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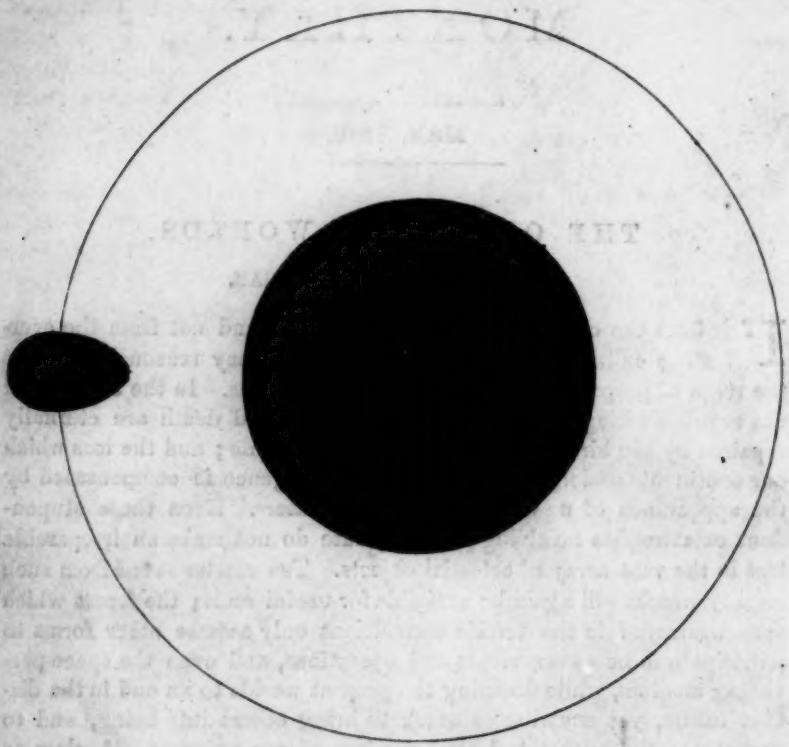
THE ORIGIN OF WORLDS.

By Professor DANIEL VAUGHAN.

IT is from the order of succession in Nature, and not from the everlasting endurance of her works, that we may reasonably expect the reign of perpetual activity in her wide domains. In the animal and the vegetable kingdoms the ravages of decay and death are eternally repaired by the birth of new representatives of life; and the loss which our continents undergo by occasional submergence is compensated by the appearance of new lands above the waters. Even those stupendous catastrophes involving planetary fate do not make an irreparable loss in the vast array of celestial objects. The matter saved from such mighty wrecks will again be available for useful ends; the forces which seem destroyed in the terrific convulsions only assume other forms to participate in new movements and operations, and even the space-pervading medium, while dooming the present worlds to an end in the distant future, yet contributes much to bring others into being, and to perpetuate the events and the wonders of our universe. A clew to the manner in which such important purposes are achieved is to be found on tracing the fate of planets or of satellites introduced into orbits of the smallest size possible; and these inquiries can be conducted with the aid of mathematical principles which are almost wholly unavailable in pursuing the details of the nebular hypothesis.

In treating on the equilibrium figure of the earth supposed to be a homogeneous fluid, Laplace has been much embarrassed on finding that, if the rotation were so rapid as to reduce the length of the day to two hours and twenty-five minutes, stability would cease to be possible, though the equatorial gravity would be only partially neutralized by centrifugal force. In solving analogous problems respecting the form of satellites confined to very small orbits and distorted from a spherical

shape, not only by diurnal motion, but by the more potent influence arising from the attraction of a great central orb, similar results may be obtained, but they admit of a more obvious explanation. The accompanying figure will give an idea of the manner in which, in such dangerous ground, a secondary planet would be affected, especially if it were composed of homogeneous and very yielding materials. If the two bodies were as disproportionate in size as Jupiter and his nearest moon, stability would be impossible on the minor one as soon as gravity



at the extremities of its longest diameter was reduced more than fifty per cent. by the disturbances. Of the fatal effects of a further reduction adequate proofs are afforded by three different modes of investigation which I have given in the "Philosophical Magazine" for 1860, 1861, and 1871. Accordingly, on coming into fatal proximity with its primary, such a satellite would not lose its matter in small portions, but would pass away in one great convulsion which would destroy the planetary condition and give birth to a ring.

The insecurity which analysis shows in this case in the mundane structure arises from the circumstance that, when gravity is reduced to less than one half its value along the greatest axis, the pressure along that line can no longer be made to counterpoise the pressure from other

directions. This rule will evidently need but slight modifications, when, instead of being so extremely unequal, both bodies have the same relation of size as that subsisting between our earth and moon, or even such as is represented in our diagram. In this case, however, the lesser body would bear a somewhat greater disturbing influence; but its dismemberment, though of a paroxysmal and a very extensive character, would be confined to the side next the primary. On losing a large portion of its mass, the satellite would swing into a wider orbit; its distance from the primary would for a long period be increased by tidal action, and many ages must elapse before they again became near enough to give occasion for a like convulsive rupture. The incorporation of a large celestial body with a greater one around which it previously revolved would thus be effected by a number of paroxysms, and would not be completed before many billions of years.

The intermittent character of these rare events would be very decided, except, perhaps, when the subordinate body were, like a comet, composed of a profusion of exceedingly rarefied gas surrounding a small, dense, central nucleus. Such differences of density as may be naturally expected in the internal and superficial matter of a satellite would tend to give the convulsive dismemberment a somewhat reduced scale, and to make it recur after less remote periods of time. But this influence would be more than counterbalanced if the incorporating body were solid, as the planetary structure would be preserved for a longer time; but, when the rupture took place, the ruin would be more extensive. Indeed, in the cases most likely to occur, the doomed planet would meet its fate in successive stages, of which the number and magnitude may be estimated with tolerable accuracy. If our moon were made to revolve about 4,500 miles beyond our atmosphere, its coalescence with our globe would be inevitable, and it would take place by about six or eight paroxysmal stages extending over a vast immensity of time. Two or three times the number of such terrific convulsions may be expected in the union between Algol and the large planet which causes his variability; and the same estimate will serve for the binary systems or the physically double stars when after long ages they become close enough for the incorporation of the less with the greater.

It is the terrific conflict of matter on such rare and stupendous events, that awakens the power which is mainly concerned in giving birth to worlds. Large primary planets would be called into being if one or both of the celestial objects undergoing these violent stages of combination had the rank of a sun. The vast mass of matter precipitated to the greater body on these occasions would sweep along its equator with furious velocity. But on the subordinate one, especially in its equatorial regions, the more superficial parts would slide over the internal nucleus in an opposite direction, in consequence of the tidal action, which in the new orbit must be powerful enough to produce not merely waves, but even progressive movements at the rate of many

leagues a second. From well-established principles and from facts made known by recent experimental researches of Edlund and Zollner, it is evident that immense currents of electricity would circulate around each mighty orb, but in different directions. On the most stupendous scale the two suns, or the sun and its great planetary attendant, would thus acquire magnetism, but have opposite polarities; and, in moving around their common center of gravity, they would exert over a wide domain the peculiar phenomenon which is but feebly manifested by a rotating horseshoe magnet.

Though the calorific effects of the encounters of great spheres have monopolized the attention of modern scientists, many facts show that mechanical action of the most extreme violence is attended with a larger conversion of energy into electricity and magnetism, and that in the case under consideration these forces must be developed on a more gigantic scale than heat and light. On the fall of a meteorite to the sun after a long course through his atmosphere on November 1, 1859, a disturbance occurred in terrestrial magnetism so quick and remarkable as to excite much attention at several stations of Europe and America. Even this circumstance alone would give grounds for a very high estimate of the magnetic agency called into being, if an amount of matter more than a thousand times that contained in our globe were hurled almost horizontally over a solar surface with a velocity of two or three hundred miles a second.

The consequences of the movements of the two great bodies, with the new properties which they assume in these convulsive stages, may be accurately traced by the aid of scientific principles for which Arago furnished a basis in 1825. Observing that, in the neighborhood of copper, water, glass, and other substances, a magnetic needle had its oscillations curtailed in the same manner as if it encountered the resistance of a medium, he endeavored to unravel the mystery by additional experiments, and was finally led to the discovery of magnetism of rotation. The researches which he commenced were continued successfully by Babbage, by Sir John Herschel, and others; it was found that a horseshoe magnet rotating around its axis would impart its circular motion to disks of copper with which it had no connection; but the inquiry was carried still further by Faraday, who proved all the effects on the electrical development attending the movement. Reasoning from what is known of such kinds of action, it is evident that the rapid revolution of the two great magnetized orbs could not sensibly affect the motion of preëxisting planets nor even of asteroids in the solar system; but it would alter much the courses and velocities of meteorites and meteoric dust; and it would be likely to make its influence felt in whirling the nebulous matter supplied by comets or separated from the equator of the greater central sun. At that theatre of violence, the matter would be dissociated perhaps into the sub-elements of Lockyer, and it would be quickly spread around, along the equatorial plane; so

that the electro-magnetic power would be favored with a good conductor for extending its control to great distances, and its effects can be traced without having recourse to any unwarranted assumptions respecting the passage of electricity through an absolute vacuum or through interstellar space.

The operation of such an agency in the heavens is shown by researches of a different character. M. Gaston Plante, of Paris, has been led by experimental evidence alone to ascribe the form of the spiral nebulæ to electro-magnetic action; as their peculiar features correspond exactly to that which he produced by powerful electric currents under the controlling influence of a magnet. But the influence of the same forces is strongly impressed on the form of another class of nebulous objects. By investigations similar to those of Laplace in regard to the possible extent of the solar atmosphere, it may be proved that a rare gas surrounding a dense nucleus and with a uniform rotation could not be compressed in a greater degree than to show a thickness two thirds of its equatorial dimensions. Yet in many nebulæ with a central condensation the greater diameter is more than four times the less, and this would seem to indicate the operation of some force like dynamic electricity acting along the plane of the equator of these rarefied objects. The evidence on this point will seem stronger when we recollect that observation gives only an inadequate picture of the effects of this cause; as, in consequence of the position in which they are viewed, planetary nebulæ scarcely ever exhibit the full amount of their ellipticity or compression.

Other facts assist in revealing the nature of the forces at work in these celestial curiosities. Judging from peculiarities they present in the spectroscope, Lockyer and Frankland have concluded that several of the nebulæ must possess an exceedingly low temperature. Yet it is difficult to conceive that such cold, rarefied masses could be self-luminous, or that they could be visible to us even when surrounding a central sun, for gases have but a very feeble power of reflecting light. The difficulty, however, may be removed by supposing that the visibility of these nebulæ depends on the passage through them of electricity developed in some dark or bright binary system on the incorporation of the lesser with the greater orb. In this way an explanation may be found for the mysterious and unaccountable variations in the brightness of these objects. From the careful observations of Hind, D'Arrest, and other astronomers, it has been shown that, in a few cases, nebulæ have declined in light so as to become invisible, but reappeared after a time; thus exhibiting changes equally fatal to the ideas that they are congregations of stars or collections of fire-mist gradually cooling and condensing into planetary systems. But the mystery will be removed when we regard their light as dependent on the electro-magnetic action already described; for in its latter stages, especially when the tides on the smaller member of the binary were drawing to a close, there would be

occasional interruptions in the production of electricity and in its passage into space.

In ascribing to meteors an important part in the train of events which these widely extended forces are capable of producing, it is not necessary to adopt the extravagant estimates which were made of the numbers of these vagrant bodies in order to support a recently exploded theory in regard to the origin of celestial light. According to some eminent scientists, the amount of meteoric matter which falls to the sun's surface every year would increase his diameter annually about two hundred and forty feet, and it would exceed the mass of Mars. But from their occasional falls to the earth, and from other facts, it may be safely concluded that the number of meteors which become tenants of the solar dominions in the course of one or two millions of years, would afford material enough to form a planet as large as the earth, even if half their numbers could be made to unite into one body, instead of being allowed to rove indiscriminately through the system and to fall to the larger spheres. Now, the arrangement necessary for such a union would arise in our supposed binary system from the movement of the two suns in their magnetized condition around their common center of gravity. The powerful display of electro-magnetism succeeding each stage of dismemberment would gradually bring the majority of all the wandering meteors into the same plane, and give them orbits of a larger size and constantly approaching nearer to a circular form. Though constantly declining, this force must, during many thousand centuries, exert a predominant sway over meteors and comets, collecting them on the verge of the binary system in such numbers and in such a regular array that their aggregation into one body, though long deferred, would be inevitable. A nucleus once formed would increase by appropriating matter from the zone which it traversed, and, though at first much retarded in its growth, it would after many thousand revolutions attain a planetary size. Being largely composed of gaseous matter and therefore very sensitive to the resistance of a space-pervading medium, the newly formed planet would contract its large orbit; and room would be thus made for bringing into being another mundane structure when, after the lapse of millions of centuries, another paroxysmal stage of incorporation awakened electric energy and prepared the way for a new coalition of the vagrant matter of the celestial regions. After numberless ages the recurrence of the dismemberment would give existence to another planetary orb, and increase the mass of the preëxisting ones. Accordingly, the verge of a solar system must be considered as the birthplace of all its primary worlds.

It is evidently in this external zone, where solar attraction is most feeble, that we may hope to find the most favorable conditions for the union of small into large masses. In the asteroidal region two spheres of granite, having each a diameter of one hundred miles, could not control the velocity with which they would sweep by one another on meet-

ing if the planes in which they moved differed one degree in their inclinations to the ecliptic. A slight difference in the size or in the shape of their orbits would also be an unsurmountable barrier to their union. If a collision should occur between two asteroids, they would be only shattered into fragments, and a coalescence into one mass would be rendered more hopeless. But on the extreme verge of a solar system the numerous meteors consigned to large circular orbits lying in the same plane would have very nearly the same velocity in contiguous zones, and would be ready for the work of aggregation when their numbers were sufficiently increased by a long-continued electro-magnetic action.

In such an innumerable group of small and light bodies in symmetrical array, a large meteorite or the nucleus of a comet might become the embryo of a future world which may require many thousand years to attain the mass of one of the average asteroids. But its attraction after a time must become powerful enough to clear a large tract of space of matter, and thus to divide into two zones the great ultra-planetary ring of floating matter, while it must gradually make the paths of the small bodies deviate from true circles. From the outer zone it receives the meteors, which are in the perihelia of their orbits, and have their velocity most rapid; but the meteoric bodies from the internal zone unite with the growing mass near the points at which their motion is reduced to the lowest rate. Accordingly, the rotation of the new world must be in the same direction in which the constituents of the great ring were moving, and in which the parent orbs moved around their common center of gravity. The same direction of motion would also be exhibited by meteors which, instead of incorporating at once with the growing world, only described ellipses around it in accordance with the law of gravity.

In this early stage of its existence a world would be able to acquire a large train of meteors revolving permanently around it chiefly in consequence of two circumstances: The rapid increase in the mass and the attraction of the growing planet will make the velocity gained by bodies in approaching it always less than that lost while they are retiring; and orbits, even when slightly hyperbolic, would be changed into ellipses. Besides this, the vast atmosphere of nebulous matter around the new-born sphere would be more effective for the same end, as it would check the velocity of the passing meteors and cause them to revolve around the growing mass long before they incorporate with it. It is in consequence of these meteoric falls, and not the mere process of cooling, that the abundance of cometary and nebulous matter surrounding a young world is brought into a more dense condition. A planetary atmosphere of oxygen and hydrogen would maintain a gaseous form in spite of the refrigerating influence of many ages; but it would be quickly converted into aqueous vapor by the chemical forces awakened on the fall of a meteoric stone, and in the course of time might become liquid or solid as it parted with heat.

If in the immense annular group of bodies two centers of aggregation formed the two incipient worlds, ever increasing, their attractive power would be likely to form a binary system, both moving around the common center of gravity between them. It is when their conjunction takes place near the point where their orbits come nearest together that such a change may be expected. The inner planet having, then, its minimum and the outer its maximum velocity, the movement in the new binary system would be in the same direction as the common orbital motion around the central suns. To such a course of events may be ascribed the origin of the earth and moon, as well as the connection which exists between them; for even tidal action would be sufficient to reduce the eccentricity of the lunar orbit to its present state. If at that early period meteoric and cometary matter were so abundant that both orbs could become twenty times as large and massive, their distance apart would be so much reduced that the moon would long since have incorporated with our globe by a series of paroxysms which would arouse electro-magnetic forces into action and give birth to a family of satellites.

When, however, two embryonic planets, in the contiguous zones of the great ring of meteors, formed a binary system long before attaining their full size, their union would take place like that of greater masses, and be attended with like consequences. It is reasonable to suppose that, in the early stage of its existence on the verge of the solar system, Mars, like our earth, received a companion having about one or two per cent. of his mass, but confined to a small orbit. This primitive attendant, which was probably over one thousand miles in diameter, subsequently united with Mars by a series of convulsive stages; and, by awakening electric agencies, gave birth to a family of satellites of which Deimos and Phobos alone remain. The career of Jupiter and Saturn was characterized by the same train of changes and events. When they first sprang into existence, in the outer zone of our system, each of these great planets was attended with a large companion which subsequently incorporated with the superior orb by a series of paroxysms, and thus occasioned the birth of a family of minor worlds. Accordingly, in a system of classification based on their modes of origin, neither our moon nor perhaps that of Neptune could be assigned to the same class which includes the satellites of Mars, Jupiter, Saturn, and Uranus.

The very great disproportion between the world-forming power in great and in small binary systems, will appear in a clearer light by considering the violence in both cases attending precipitation from the less to the greater orb. Were our moon placed so near us that it must yield to the rupturing forces, each paroxysmal dismemberment would give to the earth a ring of lunar matter having a transverse section of 30,000 square miles, and forcing its way through the outer terrestrial structure with a velocity of five miles a second. But if the linear dimensions of

both bodies were ten times as great, the conflict of the invading mass would be about 100,000 times as violent, and a correspondingly greater amount of energy would be converted into electric, magnetic, and calorific forces. Accordingly, great suns, in passing through their most terrific scenes, call forth a world-making power of the greatest vigor; and will not only give birth to larger spheres, but also send them forth in wider orbits.

But the size and mass which a world attains must depend mainly on the numbers of meteors and comets frequenting the solar dominions while it was in the course of formation. At the birth of Jupiter this vagrant matter was more than usually abundant, and it served to give the planet a predominance over the other members of the solar family. It is very probable that the minute and the rare tenants of space are very numerous in the Milky Way; but this abundance of chaotic material, though calculated to increase the size of worlds, must shorten their term of existence, as the increase which suns obtain in mass and attraction would have the same effect as a resisting medium in abridging the lives of their planets. Events involving the mortality of worlds would thus become more frequent; and it is worthy of remark that it was in or near this part of our universe that most of the temporary stars have sent forth their sudden display of brilliancy. In such a region a planet of large size in closing its career by incorporating with a sun would be attended by an electro-magnetic energy sufficient to give birth to another planetary member of considerable magnitude on the outer zone of the solar system, so that the existence of worlds would not be wholly dependent on the union of double suns.

But even in our own part of the celestial domain there are to be found evident marks of the occurrence of one of those stupendous events to which I have ascribed the appearance of temporary stars, and which are so intimately connected with the birth and death of worlds. On comparing the observations of Carrington and Spoerer with those of Vogel and Young, it appears that for the sun's equatorial zone the time of rotation is scarcely twenty-two days, while it is nearly four weeks for the parallel of fifty degrees. So great and unexpected a difference in the diurnal motion of its parts proves that our central luminary must have at some past time received a large mass, which had a direct motion over his equator, and was finally precipitated to his surface. Whether the incorporating mass was a planet, or the last remains of the great companion which coöperated in giving being to the solar family, the effects deserve attention so far as they show the present working of a power which has been long in a declining condition. The movement of one zone of matter over another having a different velocity of rotation must be a source of solar magnetism, and this force may be therefore regarded as much weaker than it was a million years ago, but much stronger than it will be in very distant future ages.

Yet, even in its reduced state, this magnetic agency is not without

control through a wide range of space. If the loss of meteors which become a prey to the attraction of great spheres be replenished by the entrance of new ones into our system, the new visitants from ultra-planetary space would, in consequence of a resisting medium, be found in the greatest numbers along the line of the sun's progressive motion. The arrangement seems, however, to be modified by the sun's magnetism, which, by favoring direct motion in the plane of his equator, gradually leads to the meteoric array which is manifested in the appearance of the zodiacal light. That this light is reflected by innumerable meteors, is an opinion which has long been maintained, and which has been confirmed by late observation; but it is only from the physical consideration which I have presented, that we can account for the permanence of a phenomenon depending on the presence of objects of so minute and perishable a character. To the same cause may be ascribed the direct motion of the comets of short periods of revolution. These effects will give some idea of what might be accomplished by solar magnetism when, as in the cases I have considered, it becomes many million times more powerful than that of our sun, and when it is favored with all the conditions for arranging chaotic matter for a transformation into worlds.

THE GROWTH OF THE WILL.

By ALEXANDER BAIN,
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I DESIRE to offer a few observations in reply to the paper by Professor Payton Spence, in the August number of the "Popular Science Monthly,"* on my theory of the growth of the Will.

By a calculation of the chance coincidences of the muscles of the human body, Professor Spence appears to reduce to an utter absurdity any theory that makes the will depend upon trial and error. At the same time, he finds in the doctrine of evolution an easy way out of the difficulty.

1. My first remark is, that I from the first assumed a large number of instinctive connections among our organs, not perhaps so large a number as may now seem requisite, but still so many as to reduce greatly the random tentatives in new acquisitions. In my chapter on instinct ("The Senses and the Intellect," and mental science) I described under reflex actions and primitive combined movements, numerous instinctive groupings of considerable complexity on which the will can build its subsequent powers. I set no limit to the number of such instincts; only, I did not refer to any that were not more or less immediately apparent. I reasoned out the locomotive rhythm in the human

* "Voluntary Motion," by Prof. Payton Spence, M. D.

subject, notwithstanding that it can not be manifested at birth, as in the case of quadrupeds.

2. When I composed "The Senses and the Intellect," the doctrine of evolution was not before the world in any shape. I made no attempt to frame an hypothesis to account for our instincts; I assumed them as I found them, and described the progress of the individual acquisitions as they appeared to my observation. In my subsequent writings I have made ample use of the hypothesis, so far as I think it agrees with the facts. I may refer more particularly to the third edition of "The Emotions and the Will," published not long ago. In "Mental and Moral Science" I allow for the probability of hereditary acquisitions in reference to the various relations summed up in the knowledge of space.

3. My theory of the will, as first conceived, was the expression of the facts as I was able to view them at the time. I regarded as acquisitions everything that appeared to need teaching in some shape or other; as, for example, speech. I inquired what were the powers that existed in the absence of teaching, and what were those that came into being only by teaching, or by some sort of experience or acquirement. I may have misconceived the scope of the two departments; but, to the best of my knowledge at the time, I endeavored to appreciate the extent of each. I saw that an infant at the end of a few months could perform simple articulations, as *wa*, *na*, *bo*, *bu*, and that on these could be based the instruction in speech. I did not consider that the articulations could be taught; I was inclined to believe that they might be stumbled on by random tentatives. I now proceed to remark on Professor Spence's *reductio ad absurdum* of that operation.

4. When the Professor talks of the number of muscles that must come into play in pronouncing the letter A, and of the enormous unlikelihood of a child stumbling on the right one in a few months, he leaves out of account various circumstances. For one thing, the combinations are absolutely limited by mutual conflict; only such groupings as can go together are to be allowed. How far this would reduce the possible number of trials I do not say, nor do I mean to affirm that the number would not remain very large; still his figure would be very seriously reduced. I will take a more patent example than speech, namely, the movement of the eyes. We know that six muscles are at work; and, allowing several gradations of energy to each, say four, there are twenty-four elements to play upon in every variety of combination. But now, instead of summing the arithmetical possibilities of union among these elements, let us survey the outcome. Of course in many of the combinations, as when two opposing muscles were equally stimulated, there would be no result; there would be simply a shock of painful collision. When the stimuli are unequal, there would be motion in some one course—up, down, right, left, slanting, curved. The possibilities now are not so very formidable: the eye can only

sweep over its field of vision to and fro, here and there; its movements might conceivably be very numerous, but all the purposes of voluntary acquirement might be served without a very great number.

Because the muscles admit of all these possible stimuli, it does not follow that the brain will ever impart them all. The limits of the motor centers would be the limits of the spontaneous impulses. The workings of the system are brought within a narrow routine, from the deficiency of the nervous matter. There are possibilities of combination of the muscles of the eyes that may never have been realized by the educated eye, far less by the uneducated eye.

Take, again, the swing of the limbs. Many muscles are at work, and many possibilities of union are open; but how few are actually realized! The supposition of the vastness of the possible combinations cuts two ways: it opens up an almost infinite source of active capability. For, although it might be long ere we reached some one particular combination, yet, out of the number of combinations that we might make, we should fall upon manifold obvious utilities that would be soon confirmed into useful habits. The same end may be served by many varieties of means; there might be fifty thousand routes of the hand to the mouth, but, provided it got there anyhow, all would end well. The observation would apply generally to Professor Spence's millions of possibilities: many thousands of them would equally hit the same mark.

5. I might dwell at greater length on the two limiting considerations now adduced; that is to say (1), the limits of the central mechanism, and (2) the equal suitability of many thousands of the supposed possible combinations to given ends. I go on, however, to cite the most important qualification of all—the self-controlling power of the active mechanism. This is the assumption needed to account for the origin of voluntary power, whether in the individual or in the race. To expatiate upon this would only be to repeat what I have said in my writings; and I could not, in a short space, say anything that would be likely to satisfy Professor Spence. I prefer for what remains of my paper to comment upon his own theory, namely, the doctrine of heredity or evolution, which he puts forward as the true solution of the difficulties of the will. In the first place, however, I refer him to "The Emotions and the Will," third edition, p. 318, where I endeavor to show that the postulates of my theory of will—namely, spontaneity, the law connecting pleasure with increased vitality, and the contiguous growth of accidental connections—are indispensable to the evolution doctrine, as stated by Spencer and Darwin. What I mean now to affirm is, that precisely the same difficulty, arising from millions of possibilities of combined action, occurs at every step of our progress by evolution. The only thing that serves to abate the difficulty is that, when a happy combination is once struck, it is hereditarily transmitted and becomes a possession for ever. This would be an important mitigation, if hereditary transmission were easily and soon effected; but the facts show

clearly that a vast space of time is required to bring any acquisition up to the point of being transmitted to a perceptible amount. So that the time obstacle still recurs; and Professor Spence's difficulty of permutations and combinations recurs with it. Indeed, if his computations were good as against my view of the will, it would be little less crushing against the start of voluntary power in the race: we should need to substitute, in order to the development of humanity, for millions of years, millions of millions. It is evident, to me at least, that there must be a shorter road, in both cases, than his calculations would suppose.

6. I am quite ready to grant that our voluntary acquisitions repose upon certain established tendencies—call them instinctive or hereditary—and that the Professor is perfectly correct in describing the mature will as a mixture of organic maturation with proper acquisition. But I should not quite concur in his mode of expressing the proportions of the two. I think I could show that the brain of man, while it must contain at birth many preëstablished groupings or connections, is distinguished for its flexibility, adaptation, or educability; and that, if we were to sum up the contents of any of our leading acquisitions, say speech, the primordial part—the supposed capacity of articulation—which the Professor thinks would need millions of tentatives, is the base for a superstructure of enormous extent, needing nothing to account for it but the power of retentiveness operating upon these few articulate modes. Consider the power of speaking seven languages, and how little of this can be by any possibility transmitted, and we must admit that, somehow or other, a vast number of connections can be established in the lifetime of an individual; every reasonable allowance being made for hereditary tendencies.

7. In order to prove that we possess by hereditary transmission a countless number of organized muscular arrangements, upon which our acquisitions are based, Professor Spence adduces the instances of abnormal exaltation of capacity, under trance, mesmerism, somnambulism, and other extraordinary conditions. For my own part, I doubt whether these phenomena have been sufficiently investigated to be turned to this use. We may readily suppose that the hereditary tendencies may be inflamed by mental excitement to the ancestral level; in other words, that I can be made to do, without the full measure of training, all that my forefathers may have attained to. This is like the case of forgotten memories revived in fever. But that I should by being mesmerized, or by being thrown into a trance, perform feats that no one of my ancestors had ever been educated to perform—as, for example, ballet-dancing or rope-walking—is not within the legitimate application of the law of heredity. It would be like water rising above its source. I am not disputing the phenomena themselves; but I think they need some other principles for their explanation, and, if quoted as proving the extent of our hereditary organization, they have the defect of proving too much.

CLEWS IN NATURAL HISTORY.

By Dr. ANDREW WILSON.

IN the exercise of his scientific attainments, there is one aspect in which the naturalist of to-day bears a certain likeness to the detective officer. The latter is perpetually endeavoring to "strike the trail" of the offender through his dexterity in the discovery of clews to the movements of the pursued, and attains his end most surely and speedily when the traces he has selected are of trustworthy kind. The naturalist, on his part, has frequently to follow the history of an animal or plant, or it may be that of a single organ or part in either, through a literal maze of difficulties and possibilities. His search after the relationship of an animal may be fraught with as great difficulty as that which attends the discovery of a "missing heir" or lost relative in actual life; and his success in his mission is found to depend, as does that of the detective's work, simply on the excellence and trustworthiness of the clews he possesses, and on the judicious use to which he puts his "information received." It can not be denied, however, that modern aspects of science and present-day tendencies in research have largely increased the resemblance between the enforced duties of the criminal investigator and the self-imposed task of the biologist. When, formerly, the order of nature was regarded as being of unaltering kind and of stable constitution, naturalists regarded animals and plants simply as they existed. There was of old no looking into the questions of biology in the light of "what might have been," because the day was not yet when change and evolution were regarded as representing the true order of the world. When, however, the idea that the universe both of living and non-living matter had an ordered past dawned upon the minds of scientists, the necessity for tracing that past was forced upon them as a bounden duty. With no written history to guide them, the scientific searchers were forced to read the "sermons in stones" which Nature had delivered ages ago. Without clear and unmistaken records to point the way, they had to seek for clews and traces to nature's meaning in the structure and development of animals and plants; and, as frequently happens in commonplace history, the earnest searcher often found a helping hand where he least thought it might appear, and frequently discovered an important clew in a circumstance or object of the most unlikely kind.

Readers whose tastes are not materially scientific have doubtless heard much of "missing links" of nature, especially in connection with the gaps which exist between the human territory and ape-land. Indeed, the phrase has come to be understood as applying almost entirely and specifically to the absence of connecting forms between man and the apes —forms for which, in one sense, no necessity exists, inasmuch as Mr.

Darwin's theory does not demand that the gorilla or any of his compeers should be directly connected with man. The gorilla with his nearest relation lives, so to speak, at the top of his own branch in the great tree of life, while man exists at the top of another higher and entirely different bough. The connection between the human and lower types is made theoretically to exist at some lower part of the stem when, from a common ancestor, the human and ape types took divergent roads and ways toward the ranks of nature's aristocracy. But although in some cases the need for "missing links" is seen, even theoretically, to be non-existent, or at least of a widely different nature from that supposed by the popular mind, there are yet cases in which that need is very apparent, and wherein, through the persistent tracing of the clews nature has afforded, the past history of more than one race of animals and plants has been made plain and apparent. Of such clews—which are really mere traces, and nothing more—there are no better examples than the curious fragments of structures found in many animals and plants, and named "rudimentary organs." An animal or plant is thus found to possess a mere trace of an organ or part which, so far as the highest exercise of human judgment may decide, is of not the slightest utility to the being. It is invariable in its presence, and as fixed in its uselessness. It bears no relation to the existing life or wants of the animal, but may in some cases—as, for example, in a certain little rudimentary pocket in man's digestive system, serving as an inconvenient receptacle for plum-stones and like foreign bodies—prove a source of absolute disadvantage or even danger. On what theory can the presence of such organs and parts be accounted for? is a question of extremely natural kind. The replies at the command of intelligent humanity are but two. Either the animal was created with the useless appendage in question—a supposition which includes the idea that Nature, after all, is somewhat of a bungler, and that nothing further or more comprehensible than the fiat "It is so," can be said on the subject—or, secondly, we may elect to explain the puzzle by the assertion that the "rudimentary organ" of the existing animal represents a part once fully developed in that animal's remote ancestors, but now

Dwindled to the shortest span.

The rudimentary organ or appendage is represented in the animal of to-day as a legitimate heritage derived from its ancestor. It is, in short, a family feature, to which the animal is the "rightful heir," but which has fallen through the operation of natural laws and conditions into disuse and desuetude, and has accordingly suffered with the career of living nature "down the ringing grooves of change." Necessarily, this second and rational explanation of the rudimentary appendages of animals and plants is founded on the supposition that nature and nature's creatures are continually undergoing alterations, and that they have been modified in the past, as they will be in all time to come. The ex-

planation thus afforded of the nature and origin of these disused parts is endorsed by the fuller knowledge of their history; while, from a study apparently of insignificant interest, may be shown how certain of our living neighbors, along with ourselves, have, from lower states, and from the dawning epochs of the world, literally taken their place "in the foremost files of time."

As most persons who have attentively looked at any common plant can tell, four parts are included in a perfect flower. These parts or sets

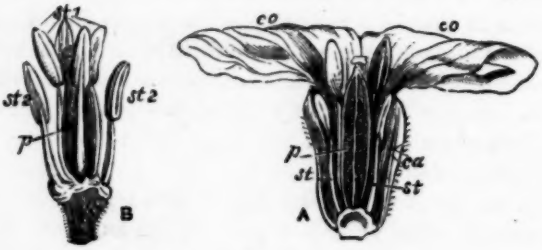

FIG. 1.

of organs, as seen in the wallflower, consist (Fig. 1), firstly, of an outer covering colored green, and named the "calyx" (*ca*). Then comes the blossom or flower itself, forming the "corolla" (*co*). Inside the corolla we find certain stalked organs, each bearing a little head or "anther," filled with a yellow dust, the "pollen." These organs are the "stamens" (*st*). Lastly, in the center of the flower, we note the "pistil" (*p*), or organ devoted to the production of "ovules." The latter, when duly fertilized by being brought into contact with the "pollen" of the stamens, become "seeds," and are capable of growing up, when planted, into new plants. Now, the botanist will inform us that it is a matter of common experience to find some individual plants of a species with well-developed petals or blossoms, and other individuals of the same species with petals in a rudimentary condition, thus proving that the production of imperfect parts in flowers occurs as an ordinary event under our own eyes, and under the common conditions of plant-life. The natural order of plants to which snapdragon belongs presents a peculiarity, inasmuch as in most of its members one of the five stamens is abortive or rudimentary. It should be borne in mind that the botanist possesses a highly interesting and exact method of ascertaining how many parts or organs should be represented in plants. He places his reliance in this respect on the working of what may be called the "law of symmetry." The operation of this law, which may be said to be founded on wide experience, tends to produce a correspondence in numbers between the parts in the four sets of organs of which we have just noted a flower to be composed. Thus, when we count five parts in the green calyx of a plant, we expect to find five blossoms or petals in its corolla; five stamens (or some multiple of five) and five parts (or

some multiple of that number) in the pistil. Where there appears to be a lack of this numerical correspondence, the botanist concludes that some violation of the law of symmetry has taken place, and that some parts or organs which should normally have been developed have been altered or suppressed. His reasoning, in fact, proceeds on the plain basis of first establishing, through experience, the normal number and condition of parts in the flower of any given order of plants, and of thereafter accounting by suppression or non-development for the absence of parts he expected to have been represented.

Now, in the snapdragon tribe, we find, as a general rule, five parts in the calyx, five petals in the corolla, but only four stamens. Such a condition of matters is well seen in the flower of frog's-mouth (*Antirrhinum*), where we find four stamens, two being long and two short (Fig 2, A s^1 s^2), as the complement of the flower. We account for the absence of a fifth stamen by saying it is abortive. But a natural reflection arises at this point, in the form of the query, Have we any means of ascertaining if our expectation that a fifth stamen should be developed is rational and well founded? May not the plant, in other words, have been "created so?" Fortunately for science, Nature gives us a clew to the discovery of the truth in this as in many other cases. In one genus of these plants (*Scrophularia*), we find a rudiment of a fifth stamen (Fig. 2, B *s*), and in snapdragon itself this fifth stamen becomes occasionally fully developed; while another plant of the order (*Mullein*) possesses five stamens as its constant provision. Unless, therefore, we are to maintain that Nature is capricious beyond our utmost belief, we are rationally bound to believe that the rudimentary fifth stamen of *Scrophularia*, and the absent fifth stamen of other plants of its order, present us with an example of modification and suppression respectively. The now rudimentary stamen is the representative of an organ once perfect and fully developed in these flowers, and which it perpetuated by the natural law of inheritance until conditions, to be hereafter noticed, shall have caused it to entirely disappear. The case for the natural modification, and that against the imperfect creation of such flowers, is proved by an ingenious experiment of Kölreuter's, upon plants which have the stamens and pistils situated in different plants, instead of being contained in the same flower, as is ordinarily the case. Some staminate or stamen-possessing flowers had the merest rudiment of the pistil developed, while another set had a well-developed pistil. When these two species were "crossed" in their cultivation, the "hybrids" or mule progeny thus produced evinced a marked increase in the development of the abortive organ. This experiment not only proved that, under

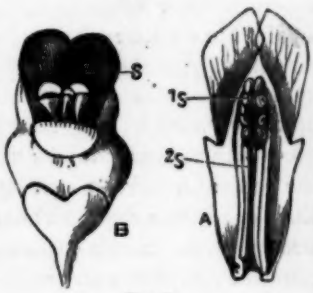

FIG. 2.

certain conditions, the rudimentary pistil could be improved and bettered, but also the identity of the two pistils, and the high probability that the abortive organ in the one flower was simply the degraded representative of the well-developed part of the other.

As a final example of the manner in which we receive clews toward the explanation of the modifications of flowers, the case of the wallflower is somewhat interesting. This plant and its neighbors possess the parts of the flower in fours. (Fig. 1, A.) There are four sepals and four petals, while six stamens (Fig. 1, B) are developed; the pistil possessing only two parts. Here the law of symmetry would lead us to expect either four stamens or eight—the latter number being a multiple of four. The clew to this modification is found in the arrangement of the stamens. We find that four of the wallflower's stamens are long (Fig. B, *st* ¹), while two (*st* ²) are short. The four stamens form a regular inner series or circle, the two short stamens being placed, in a somewhat solitary fashion, outside the others. This condition of matters clearly points to the suppression of two of an originally complete outer row of four stamens, and we receive a clew as to the probability of this view by finding that in some other flowers of the wallflower's group the stamens may be numerous. It is hardly within the scope of the present article to say anything regarding the causes of the conditions or of the agencies through which the modifications of plants are wrought out. Suffice it to remark that the "law of use and disuse" of organs explains the majority of such cases, by asserting that organs become degraded when they are no longer found to be useful to the economy of their possessors. The degradation of a part is to be looked upon as subservient to the welfare of the animal or plant as a whole, and thus comes to be related to the great law of adaptation in nature which practically ordains that

Whatever is, is right.

The animal world presents us, however, with more obvious and better-marked examples of rudimentary organs than are exhibited by the modifications of flowers—conspicuous as many of these latter instances undoubtedly are. Turning our attention first to lower life, we find among insects some notable and instructive illustrations of abortive organs, and also of the ways and means through which the rudimentary conditions have been attained. In the beetle order, the natural or common condition of the wings—which in insects typically number four—is that whereby the first pair becomes converted into hardened wing-cases, beneath which the hinder and useful wings are concealed when at rest. Now, in some species of beetles, we may meet with certain individuals with normally developed wings; while in other individuals of the species we find the wings to be represented by the merest rudiments, which lie concealed beneath wing-cases, the latter being actually firmly and permanently united together. In such a case the modifica-

tion has been extreme, but there can be no doubt that the ancestors of the beetles with modified wings possessed fully developed appendages; otherwise we must regard the order of nature as being one long string of strange and incoherent paradoxes. Mr. Darwin has given us some instructive hints regarding the modification of beetles' wings and feet in his remarks on the effects of the use and disuse of parts in the animal economy. Kirby, the famous authority on entomology, long ago noted the fact that, in the males of many of the dung-beetles, the front feet were habitually broken off. Mr. Darwin confirms the observation of Kirby, and further says that in one species (*Onites apelles*) the feet "are so habitually lost that the insect has been described as not having them." In the sacred beetle (*Ateuchus*) of the Egyptians, the tarsi are not developed at all. Mr. Darwin remarks that necessarily we can not, as yet, lay over-much stress upon the transmission of accidental mutilations from parent to progeny, although, indeed, there is nothing improbable in the supposition; and, moreover, Brown-Séquard noted that, in the young of Guinea-pigs which had been operated upon, the mutilations were reproduced. Epilepsy, artificially produced in these latter animals, is inherited by their progeny. "Hence," says Darwin, "it will perhaps be safest to look at the entire absence of the anterior tarsi (or feet) in Ateuchus, and their rudimentary condition in some other genera, not as cases of inherited mutilations, but as due to the effects of long-continued disuse; for, as many dung-feeding beetles are generally found with their tarsi lost, this must happen in early life; therefore the tarsi can not be of much importance, or be much used by these insects."

The beetles of Madeira present us with a remarkable state of matters, which very typically illustrates how rudimentary wings may have been produced in insects. Two hundred beetles, out of over five hundred species known to inhabit Madeira, are "so far deficient in wings that they can not fly." Of twenty-nine genera confined to the island, twenty-three genera include species wholly unable to wing their way through the air. Now, beetles are frequently observed to perish when blown out to sea; and the beetles of Madeira lie concealed until the storm ceases. The proportion of wingless beetles is said by Mr. Wollaston to be "larger in the exposed Desertas than in Madeira itself"; while most notable is the fact that several extensive groups of beetles which are numerous elsewhere, which fly well, and which "absolutely require the use of their wings," are almost entirely absent from Madeira. How may the absence of wings in the Madeiran beetles be accounted for? Let Mr. Darwin reply: "Several considerations make me believe that the wingless condition of so many Madeira beetles is mainly due to the action of natural selection, combined probably with disuse. For during many successive generations each individual beetle which flew least, either from its wings having been ever so little less perfectly developed, or from indolent habit, will have had the best

chance of surviving from not being blown out to sea; and on the other hand those beetles which most readily took to flight would oftenest have been blown to sea, and thus destroyed." An instinct of laziness, so to speak, alone or aided by a shortness of wing, developed stay-at-home habits; and such habits would necessarily tend toward the survival and increase of wingless forms. Other Madeiran insects—such as butterflies, moths, and flower-feeding beetles—have well-developed wings, or possess wings relatively larger than they exhibit elsewhere. This observation, remarks Mr. Darwin, is quite in consistency with the theory of the law of natural selection which favors the survival of the fittest. "For when a new insect first arrived on the island, the tendency of natural selection to enlarge or to reduce the wings would depend on whether a greater number of individuals were saved by successfully battling with the winds, or by giving up the attempt, and rarely or never flying."

Among animals of higher rank in the scale than insects, the presence of rudimentary organs is frequently to be demonstrated. What explanation, other than that of degradation and decay owing to disuse, can be offered of the case of the crabs from the Kentucky Cave?

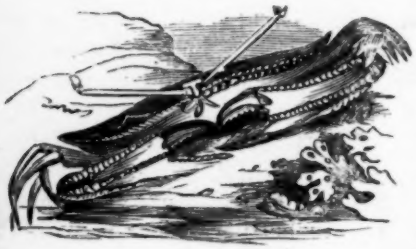

Fig. 3.

Crabs possess compound eyes borne at the extremities of highly movable stalks, these stalks in the sentinel crab (Fig. 3) being extremely elongated. In some of the Mammoth Cave crabs the stalk remains, but the eye has completely disappeared. As the eyes in such a case could in no sense disappear from any reason connected with injury to the animal, we are absolutely without any reason for their absence other than that of disuse. Professor Silliman captured a cave rat which, despite its blindness, has large, lustrous eyes. After an exposure for about a month to carefully regulated light, the animal began to exercise a feeble sense of sight. Here the modification or darkness has simply affected the function of the eye; in due time the effects of disuse would certainly alter and render abortive the entire organ of sight.

The possession of flying powers is so notable a characteristic of the class of birds that any exception to this rule, and the want of aërial habits, may be rightly regarded as presenting us with a highly anomalous state of matters. Yet instances of rudimentary wings in birds are far from uncommon; and several groups are, in fact, more notable on account of the absence of powers of flight than for any other structural features. The ostrich, for instance, represents a bird the wings of which are mere apologies for organs of flight, and which are used, as every one knows, simply as aërial paddles. The curious *Apteryx* or

kiwi-kiwi (Fig. 4) of New Zealand, a near relative of the ostriches and running-birds in general, represents a still more degraded condition of the organs of flight, for the wing is reduced in size to an extraordinary degree, and exists in a highly abortive condition; while only one complete finger is represented in the hand — other birds, as a rule, possessing three modified fingers. The logger-headed duck of South America has wings so reduced that it can but "flap along the surface of the water," a condition of matters closely imitated among ourselves by the Aylesbury duck—although, indeed, the young ducks are able to fly. The wing of the penguin (Fig. 5) is a mere scaly appendage utterly useless for flight, but useful as a veritable fin, enabling it to swim under water with great facility; and of the auk's wing the same remark holds good. In the

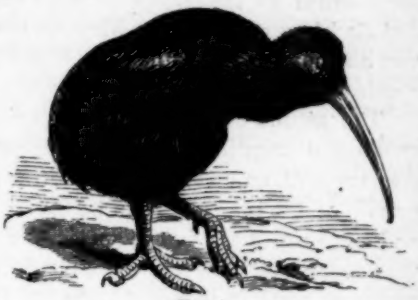

Fig. 4.

Fig. 5.

birds, then, there is ample evidence of deterioration of organs in the rudimentary nature of the wings of many species. How these conditions have been brought about is not difficult to explain in most instances. In New Zealand, where we find a singular absence of quadrupeds, wingless birds—many being extinct—of which the apteryx is a good example, take the place of the four-footed population. In view of an immunity from the attack of other animals, the ground-feeding habits of these birds would become more and more strongly settled as their special way of life; and, in the pursuit of such habits, the wings,

seldom used for flight, would degenerate as time passed. The later advent of man, in turn, has exterminated certain races of the wingless birds—such as the *Dodo* (Fig. 6) and *Solitaire* (Fig. 7) in Mauritius and Rodriguez—while the wingless and giant Dinornis of New Zealand and its contemporaries have probably been hunted to the death of their species by their human co-tenants of these strange lands.

The ascent to the quadrupeds brings in review before us still more striking illustrations of the apparently incomplete rendering of the structures of animal life. No better instance of the "rudimentary organs" of the naturalist can be found than in the group of the whales, and more especially in the species from which we obtain the commercial whalebone and oil—the Greenland or right whale. This whale possesses no teeth in its adult state, but before birth teeth are found in the gum. These teeth, however, are gradually absorbed, and utterly disappear from the jaws, the adult whale possessing, as is well known, a great double fringe of whalebone-plates depending from the palate. The same remark holds good of the unborn young of ruminants, or animals which "chew the cud"; these animals in their adult state possessing no front teeth in the upper jaw, but in their immature condition devel-

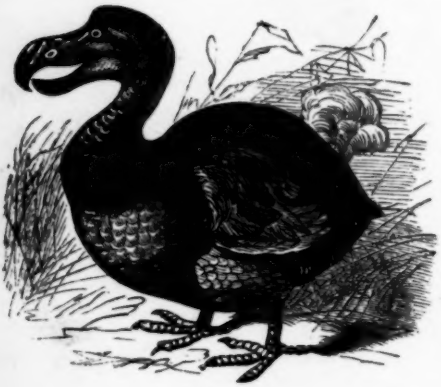

FIG. 6.

FIG. 7.

oping these organs—which, by the way, never cut the gum—only to lose them by a natural process of absorption. Now, here there can be no question of use; and certainly no adequate explanation of their occurrence exists, save that which regards these fœtal teeth as the remnants of structures once well developed in the ancestors of the whalebone whales and ruminants. To this supposition the evidence—avowedly incomplete—obtained from geology gives no contradiction, even if it does not by any means supply the "missing links" in an adequate fashion. We do know that among the oldest of the great leviathans of the past was the *Zeuglodon*, which had teeth developed much in excess of anything we find represented in the dental arrangements of the

whales of to-day—a creature this, of which, as regards its teeth at least, modern whales are but shadowy reproductions. While under the shelter of great authority we may declare this ancestor of the whale to have been intermediate in nature between the seals and whales, or between the whales and their neighbors the manatees or sea-cows and dugongs. In either case, the intermediate character of the animal argues in favor of its having been the likely parent of a race dentally degraded in these latter days.

There is little need to specialize further instances of the occurrence of rudimentary organs in the higher animals, save to remark that not the least interesting feature of such cases is contained in the fact that the milk-glands of male animals among quadrupeds—organs which exist in a rudimentary condition—have been known to become functionally active and to secrete milk; this peculiarity having been known to occur even in the human subject. Among the higher quadrupeds, however, there yet remains for extended notice one special instance of the occurrence of "rudimentary organs," wherein, not merely is the nature of the parts thoroughly determined, but the stages of their degradation can be clearly traced through the remarkable and fortunate discovery of the "missing links." Moreover, the case in point, that of the horse, so clearly illustrates what is meant by progressive development or evolution of a species of animals, that it is highly instructive, even if regarded from the latter point of view.

Fig. 8.

When we look at the skeleton of a horse's fore-limb, we are able, without much or any previous acquaintance with the facts of comparative anatomy, to see that it is modeled upon a type similar to that of the arm of man. Were we further to compare the wing of the bird, the paddle of the whale, the fore-limb of the bat, and the fore-leg of a lizard, with the equine limb, we should find the same fundamental type of structure to be represented in all. Thus we find in the arm of man (Fig. 8)—to select the most familiar example from the series just mentioned—a single bone, the *humerus* (3), forming the upper arm; two bones (*radius* (4) and *ulna* (5)) constituting the fore-arm; eight small bones forming the wrist (*carpus*): five bones—one for each finger—forming the palm or *metacarpus;* and five fingers, each composed of three small bones, named *phalanges*, with the exception of the thumb, in which, by a mere inspection of that digit, we may satisfy ourselves only two joints exist. In the wing of the bird (Fig. 9) we find similarly an upper-arm bone or *humerus*, two bones (*radius* and *ulna*) in the forearm; a wrist (*b*), a thumb (*g*), and two fingers (*c f e d*). Now, turning to the fore-limb of a horse (Fig. 10)—the hind-limb being essentially similar, in its general conformation, and corresponding as closely with man's lower limb—we find its conformation to correspond in a remarkable fashion to that

of man's arm. First, there is the *humerus* (*h*), a bone of the horse's upper arm, concealed, however, beneath the skin and muscles, and being, therefore, inconspicuous in the living animal. The horse's forearm, like that of man, contains two bones—*radius* (*r*) and *ulna* (*u*)—it is true; but the *ulna* has degenerated in a marked degree, and exists as a mere strip of bone which is tolerably distinct at its upper end, but unites with

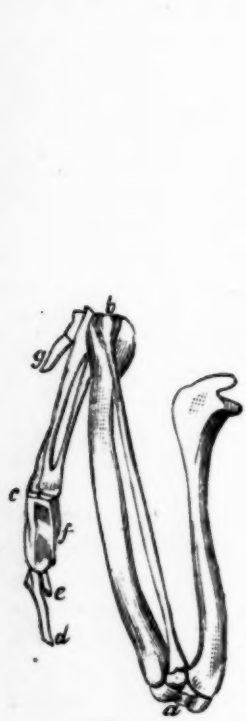

Fig. 9.

Fig. 10.

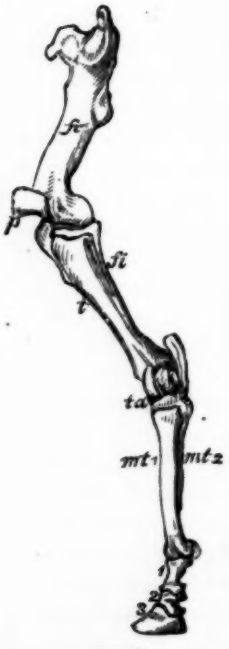

Fig. 11.

and merges into the other bone, the well-developed *radius*. The wrist (*w*) of the horse naturally succeeds its forearm, but from the fact of the upper arm being concealed beneath the skin and muscles, the wrist is commonly mistaken for the horse's knee. Thus, when a horse chips its "knee," it in reality suffers a contusion of its wrist. Man possesses eight bones in his wrist, the horse has only seven, but the equine wrist is readily recognizable as corresponding with the similar region in man. The greatest difference between the human limb and that of the horse is found in the regions which succeed the wrist, and which constitute the palm and hand. Man has five palm-bones: the horse has apparently but one long bone, the "cannon-bone" (m^3), in place of the five. Now, to which of man's palm-bones does this "cannon-bone" correspond? The anatomist replies, "To that supporting the third or middle finger"; and attached to this single great palm-bone the horse has

three joints or "phalanges" (1, 2, 3) composing his third finger. These joints are well known in ordinary life as the "pastern," "coronary," and "coffin bones"; and the last bears the greatly developed nail we call the "hoof."

Thus the horse walks upon a single finger or digit—the third; and it behooves us to ask what has become of the remaining five—the highest number of fingers and toes found in mammals or quadrupeds? We find that, with the exception of other two—the second and fourth fingers—the horse's digits have completely disappeared. The second and fourth fingers have left mere traces, it is true, but it is exactly these rudimentary fingers which serve as the chief clews to the whole history of the equine race. On each side of the single palm-bone of the horse's great finger, we see two thin strips of bone (one of which is represented at m^3 Fig. 10), which veterinary surgeons familiarly term "splint-bones." (See also Fig. 12 A, *d*). But these "splints" bear no finger-bones, and the condition of the horse's "hand" or fore-foot is therefore seen to be of most noteworthy and curious conformation. It may, indeed, sometimes happen that the small pieces of gristle or cartilage may be found at the base of the splint-bones, and comparative anatomists incline to regard these gristly pieces as the representatives of the first and fifth fingers. But the ordinary condition of the horse's hand may be summed up by saying that the animal walks on one well-developed finger—the third—and possesses the rudiments, in the form of the "splint-bones," of other two fingers, the second and fourth. These latter, it need hardly be added, are completely concealed beneath the skin and other tissues of the limb. In the hind-limb of the horse (Fig. 11), a similar modification is observed. The thigh-bone (*f e*) and knee-cap (*p*) are readily observed. There is but one toe—the third (^{1}, ^{2}, ^{3})—supported by a single cannon-bone (mt^1); and there are likewise two splint-bones (one depicted at m^2), representing the rudiments of the second and fourth toes. The horse's heel, like his wrist, appears out of place, and is popularly named his "hock." The shin-bone (*t*) is the chief bone of the leg, and has united to it the other bone (*fi*) succeeding the thigh, named the fibula, and which is seen in man's leg, and in that of quadrupeds at large.

To the eyes even of an unscientific observer, who sees the skeleton of a horse placed in a museum, in contrast with the bony frames of other and nearly related animals, the equine type is admittedly a very peculiar and much modified one. In place of five toes, we find but one; and in the matter of its teeth, as well as in other features of its frame, the horse may be said to present us with an animal form which appears as a literal example of Salanio's remark that

> Nature hath framed strange fellows in her time.

A person of a thoroughly skeptical turn of mind might possibly demand to know the exact reasons for the assumption that the splint-

bones of the horse are in reality the rudiments of the fingers we have represented them to be, and might further demand proof positive of their nature. Fortunately, geology and the science of fossils together come to our aid, with as brilliant a demonstration of the steps and stages of the degradation of the horse's fingers as the most sanguine evolutionist could hope to see. From Mother Earth, whose kindly shelter has sufficed to preserve for us the remains of so many of the forms of the past, we obtain the means for constructing a genealogical tree of the equine race, by methods of certain kind, and through the exhibition of fossils, each bearing an impress of its history, which, to use Cuvier's expression, "is a surer mark than all those of Zadig."

Our theoretical journey backward into the ages begins with the Recent or last-formed deposits—those which lie nearest the outer surface of our earth. The Recent or Quaternary period forms a division of the Tertiary period, that is, the latest of the three great epochs into which, for purposes of classifying fossil forms by their relative ages, the geologist divides the rock-formations. The Tertiary rocks, commencing the list, with the last-formed or uppermost strata, begin with the Quaternary or Recent deposits; next in order succeed the older Pliocene rocks; then come the Miocene formations, and lastly succeed the Eocene rocks. These last are the oldest of the Tertiary period, and lie in natural order upon the Cretaceous or Chalk Rocks, which themselves belong to an entirely different and anterior (Mesozoic) period in the history of our globe. The first fossil—that is, the last-deceased—horses we meet with are found in the Quaternary and Pliocene, or the last-formed deposits of the Tertiary system. Between these earlier Pliocene horses and our own Equidæ there are no material differences; and the limbs of these forms may therefore be diagrammatized as depicted in Fig. 12, A A^1; the cannon-bone in all of these figures being marked *a;* the splint-bones *dd;* the "pastern" and "coronary" bone *b*, *c*, and the "coffin-bone" *f*.

But near the beginning of the Pliocene formations of the Old World, and in the oldest of the Miocene rocks which lie below them, we find a member of the horse family which differs in certain important respects from the horses of the Recent period, and from those of to-day. The fossil horses alluded to are found not merely in Europe, but in the Sewalik Hills in India, and they must therefore have possessed a very wide range of distribution. When first discovered, M. de Christol called this species of horse *Hipparion*, a name which has been still retained for it, amid that constant alteration in zoölogical nomenclature which is the labor of the foolish and the sadness of the wise among us. What are the chief peculiarities of Hipparion? Briefly stated, in the larger development of the "splint-bones" (Fig. 12, C C^1), which, according to Owen, must have "dangled by the side of the large and functional hoof (or third toe) like the pair of spurious hoofs behind those forming the cloven foot in the ox." This conformation, continues Owen, "would

cause the foot of the Hipparion to sink less deep into swampy soil, and be more easily withdrawn than the more simplified horse's foot." Furthermore, the ulna or bone of the forearm, deficient in the horse of to-day, is tolerably well developed in Hipparion.

Backward in time, and in the older Miocene formations of Europe, another fossil horse was disentombed, and was duly described under the name of *Anchitherium*. This latter horse possesses a completely developed ulna in the forearm, and fibula in the leg; but its chief point of interest lies in the fact that each foot possessed three fully developed toes (Fig. 12, D D^1 *d*, *d*, *c*) which apparently must have touched the

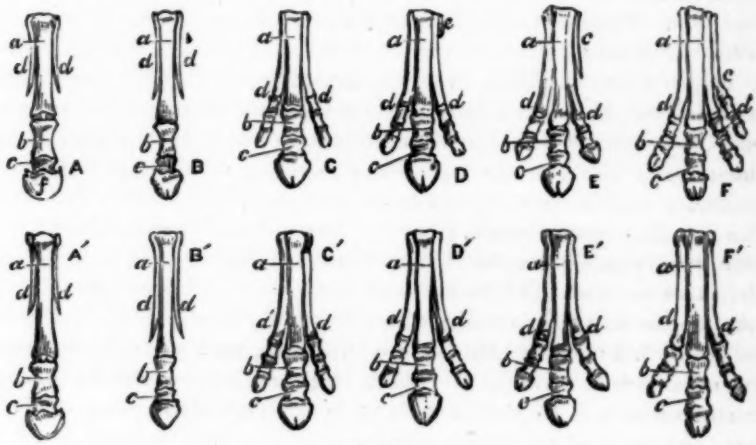

FIG. 12.

ground in walking. Already, our splint-bones are seen to better their condition as we pass backward through the ages, and to appear as the natural supports of well-developed second and fourth toes. Here the geological history of the horse in the Old World may be said practically to end. Modern history assures us that the first horses which peopled the New World, and whose descendants roam over American prairies as the famed mustangs, were imported by the Spaniards at the period of the Mexican conquest. Geology has a more curious tale to relate of the New World horses and their history, and gives them an antiquity compared with which the events of man's primitive history in either world are but as yesterday. Recent researches among the rock formations of Western America, in particular, have shown us that it is to the New World we must look for a perfect pedigree of the horse. For, beginning with the horse of to-day, with its splint-bones, we are carried gradually backward in time to the Pliocene horse of the New World named *Pliohippus* (B B^1)—a form not differing materially from the living horse, but serving in a very graduated fashion to introduce us to the older *Protohippus*, the New World representative of our own fossil Hipparion (C C^1), and in some respects a more typical three-toed

horse than the latter. Our own Anchitherium (D D') corresponds to the next specimen of the New World—*Miohippus* by name; and Miohippus evinces a still more important modification in that it possesses a rudiment of the fifth or little finger in addition to the second, third, and fourth digits with which the fore-feet are provided.

The American horses now continue the history of the race in time past without aid or representative from the eastern hemisphere, in so far, at least, as the latest research has shown. To Miohippus succeeds the *Mesohippus* (E E') from the American Miocene, which has three well-developed toes, and in addition shows the rudiment of the little finger (E *e*) of the fore-feet (seen also in Miohippus, D *e*) in an enlarged condition. Passing to the Eocene formations, the oldest series of the Tertiary rocks, we meet with the next step in the form of the *Orohippus* (F F'), in which the little finger (*e*) appears as a veritable member of the hand, the hind-feet still possessing three well-developed toes only: while, consistently with the development of the toes, the ulna of the forearm and fibula of the leg appear as bones of legitimate size, and present a striking contrast to their rudiments in the horse of to-day. The last discovered horse is from the oldest of the Eocene beds; it has been appropriately named *Eohippus*, and presents us with four complete toes (second, third, fourth, and fifth) on the fore-feet, and a rudiment of the first toe as well; with a trace of the fifth toe of the hind-feet—this last member being, as we have seen, unrepresented in any of the other forms. When the Chalk Rocks shall have yielded up their fossil horses, it is consistent with logic and reason to expect that the primitive stock of the horses will be discovered with its complete provision of five toes, and its corresponding modifications of form.

To what conclusions, of reasonable kind, do these stable facts regarding the pedigree of the horse naturally lead? The answer is toward a belief in the slow and progressive modification and evolution of the one-toed modern horse from a five-toed ancestor. This process of modification must, of course, have affected its entire frame, but it is sufficient for our present purpose to point out that in the structure of the foot alone we discern the evidence for evolution, as clearly as in the entire organization of the animal. An increase of speed, and obvious advantage over its enemies, would be gained by the horse, as its toes grew "small by degrees and beautifully less"; and the single-toed race has thus practically come to the front in the world of to-day, as the plain and favorable result of the work of degradation among its digits.

Two bony shreds or rudiments thus lay the foundation of a grave conclusion regarding the horse and its manner of development, and exemplify the adage that great and unlooked-for results sometimes spring from beginnings of apparently the most trifling kind. The "splint-bones" form, in fact, a clew which, when rightly pursued, leads not merely to a knowledge of the evolution of the horse, but to an understanding of the entire scheme of nature. The idea, then, of

"special creation" of the horses does not look well, it must be confessed, in the face of the gradual and obvious modification exhibited by the series of fossil horses, which leads without a break from Eohippus to the modern horse. At most, it may be said, there is but a choice of probabilities offered us. And in the adoption of a scheme of development, and in face of the facts laid before us, it is hard to see any grounds whereon the special-creation theory can be maintained, or the theory of progressive development and evolution denied. For if evolution is the law of the horse's history, it must logically follow that it represents the scheme of nature throughout: since the uniformity of nature, in which we are bound to believe, and to which we are bound to appeal, would utterly negative the idea that evolution should hold good for the horse, and be inapplicable to any other living thing. Because the missing links are not so completely supplied to us in other cases as in the horse, we are not on that account entitled to assume that the theory of development is invalid. We may not see an oak-tree grow inch by inch, but we are as positive as our mental nature will admit, that the oak was once an acorn, and that there has been a progressive growth and increase which might not be apparent to us were we to watch the tree for weeks together. Applying this reasoning to the case before us, it would be as illogical to deny that the order of nature was that of development, as to insist that the oak was created as it stands. The extent of human knowledge, and the duration of human existence, are together inadequate to enable us to discern the progress of this world's order after the fashion whereby, from a lofty elevation, we may trace every winding of a stream. But the probabilities of the case are as overwhelmingly for progressive development, as the direct evidence at hand—exemplified by the horse's pedigree—tells against special and independent creation having been the way of the First Cause in the making of the world and its living things.

The entire scheme of scientific discovery thus depends very largely upon the use made of the hints which nature is continually presenting to the searcher, and on the correct interpretation of the facts he is fortunate enough to elicit in his search. The study of the rudiments of animal and plant structures may well exemplify, from the importance of its results, the value of gathering up the veriest fragments of knowledge. For, as Mr. A. R. Wallace has remarked regarding rudimentary organs, "There must be a cause for them; they must be the necessary results of some great law." And again are this author's words most appropriate when he says: "Many more of these modifications should we behold, and more complete series of them, had we a view of all the forms which have ceased to live. The great gaps that exist between fishes, reptiles, birds, and mammals (that between reptiles and birds is now wellnigh obliterated) would then, no doubt, be softened down by intermediate groups, and the whole organic world would be seen to be an unbroken and harmonious system."—*Gentleman's Magazine.*

DIETETIC CURIOSITIES.

By FELIX L. OSWALD, Ph. D., M. D.

II.

WE know from the accounts of Sir John Ross, Captain Kane, and other Arctic explorers, how persistently the Esquimaux prefer walrus-blubber and whale-oil to the most seductive products of the vegetable kingdom, but the fervor of their devotion was only realized by the Rev. Mr. Hansen, the Moravian missionary, who prepared a dying Esquimau for the glories of the New Jerusalem. "I am sure you are right," said the departing brother, "but, tell me, are there many walruses in heaven?" "None at all, as far as I know," Mr. Hansen replied, not without astonishment at the question. The weary eyelids opened to emit a look of intense reproach. "And you couldn't tell me that before? No heaven that for me, then—an Esquimau can not subsist without walrus!"

The peptic stimulus of a high latitude, as recognized by Dr. Boerhaave, may justify such preferences; but Greenlanders, carried down to our temperate climate and even to the eternal summers of Cuba, still insisted on their daily blubber-ration with a firmness worthy of a better cause. Ferdinand Renz, the European Barnum, found it to his advantage to gratify the national taste of his Greenlanders. He had attempted to wean them from their traditional grease, and nearly succeeded, as he flattered himself, when his managers reported an enormous deficit of tallow-candles, which he found had been devoured by the boxful in the silence of night by the bereaved children of the North.

Nowhere is indifference to the quality of food carried further than in the rural districts of Russia. Black, sour bread, salt pork, cabbage, and *quass*, or fermented cabbage-water, are the nectar and ambrosia of the Slavonic boor, who in times of scarcity will content himself with a diet that would drive Munster and Connaught to desperation. Quass, their popular tipple, is described as resembling a mixture of stale fish and soap-suds in taste, yet has next to beer probably more votaries than any other fermented stimulant.

Assassin, *assassinate*, and their derivatives come from *hasheesh*, the Arabian word for hemp. A decoction of hemp-leaves, filtered and boiled down, yields a greenish-black residuum of intensely bitter and nauseous taste—a stuff not very likely, one should think, to tempt a normally constituted human being. Yet this same hasheesh, Dr. Nachtigal assures us, can marshal a larger army of victims than either gunpowder or alcohol; and only the originator of the opium-habit, he thinks, will have an uglier score against him on the day of judgment than the Sheik-al-Jebel, who, tradition says, first introduced the hasheesh-habit.

The effect of this hemp-extract is compared to hydrophobia: its votaries are seized with rage and restlessness, and if the paroxysm is upon them seize a knife, a stone, or anything that will serve for a weapon, and rush out to commit indiscriminate assaults, continuing to "run amuck," as the Malays term it, till the stimulating power of the drug has spent itself, or till their career is stopped by a well-aimed shot. In Batavia and other cities of the Dutch Indies there used to be a standing reward for the slaying of a "muck-runner," but even such a man as Ibrahim Pasha was not ashamed to stimulate the courage of his soldiers by the use of the detestable poison. The hasheesh-habit originated in Asia Minor, but is now practiced throughout northern Africa down to the Abyssinian valleys, and has spread eastward to the Malay Archipelago, and even to Siam, where its further progress was arrested by the determined action of the Siamese Government.

A frugal diet has this additional advantage, that simple food is in less danger of adulteration, or must at least be imitated by equally simple and harmless substitutes. Watered milk or lard mixed with corn-meal is certainly annoying, but hardly injurious, and is a trifle altogether if compared with the abominations that are half consciously consumed by the lovers of imported delicacies and expensive stimulants. Dr. Stenhouse, of Liverpool, analyzed a suspicious sample of tea, with the following result, published in the "Planters' Price Current" of February, 1871: The package contained some pure congou-tea leaves, also siftings of pekoe and inferior kinds, weighing together twenty-seven per cent. of the whole. The remaining seventy-three per cent. were composed of the following adulterants: Iron, plumbago, chalk, china-clay, sand, prussian blue, turmeric, indigo, starch, gypsum, catechu, gum, the leaves of the camellia, sarangua, *Chlorantes officinalis*, elm, oak, willow, poplar, elder, beach, hawthorn, and sloe.

There is hardly any article of food in general use which has not somewhere been converted into a stimulant by the process of fermentation. What else are whisky, rum, beer, etc., but fermented or distilled bread, the bread-corn diverted from its legitimate use to produce an artificial stimulant? Potatoes, sugar, honey, as well as grapes, plums, apples, cherries, and innumerable other fruits, have thus been turned from a blessing into a curse. The Moors of Barbary and Tripoli distill an ardent spirit from the fruit of the date-palm, the Brazilians from the marrow of the sago-tree and from pineapples, and even the poor berries that manage to ripen on the banks of the Yukon have to furnish a poison for the inhabitants of Alaska. Pulque, the national drink of Mexico, is derived from a large variety of the aloe-plant, the sap of which is collected and fermented in buckskin sloughs into a turbid yellowish liquor of most vicious taste.

Cheese, in fact, is nothing but coagulated milk in a more or less advanced state of decay. Sauerkraut is cabbage in the first stage of fermentation, which if completed yields quass, the above-mentioned Rus-

sian tonic. Chica, a whitish liquid which in Peru is handed around like coffee after meals, is prepared from maize or Indian corn, moistened and fermented by mastication.

How a fondness for such abominations is propagated can be explained by any boy who had to drink beer or eat strong cheese against his will, and by and by "rather liked it," but a question less easily answered is how such tastes ever could originate. To the first man who tasted hasheesh, alcohol, or pulque, these substances could hardly be more tempting, we should think, than coal-tar or caustic sublimate. But most articles of food and drink are older than history. All we can do is to trace their progress from nation to nation and from century to century, but their origin loses itself in the cloud-land of tradition. The exegesis of diet is as problematic as that of religious dogmas.

Natural characteristics can frequently be traced to an hereditary foible for a special diet. French wits unhesitatingly attribute the *têtes carès* of their eastern neighbors to the heavy black bread of the land of Thor, and hint strongly that the reticence and stubbornness of John Bull have more to do with his beefsteaks than with mental profundity.

"Alas, how helpless is theology against the diet of bull-beef!" writes Father De Smet in his yearly report from the Sioux missions. It certainly is a suggestive fact that agriculture had to precede Christianity in its conquests over the aboriginal North Americans. Not one of our Indian tribes would renounce the devil and all his works unless we could get them to renounce the buffalo first. I heard a vegetarian lecturer in New Orleans last year, who gave a *résumé* of the peculiar views of his people, and certainly made out a very strong case in their favor. "The aggressive, the belligerent, and bloodthirsty instincts of all nations," he said, "are exactly equal to the proportion of animal food in their diet. The Hindoos, who like pigeons seem to be 'born without gall,' are vegetarians from birth; so were the Lotophagi of antiquity, who compromised all differences by arbitration. The Malays, who, in the same climate and with the same advantages, make use of animal food, are notoriously cruel and quarrelsome. But in the Indians of North America, who are wholly carnivorous, human nature and native pity seem to have become extinct, and superseded by an artificial instinct of bloodshed which equals that of the most ferocious animals."

The Mexicans distinguish between *Indios mansos* and *Indios bravos*—tame and fierce Indians—between whom there seems to be no generic difference; but the eastern tribes are frugivorous, cowardly, and harmless as Hindoos, though in stature and facial characteristics exact copies of their western kinsmen, the flesh-eating Comanches, who in cruelty emulate the pirates of Malacca.

Erasmus complains of the porcine paunches and materialistic tendencies of his countrymen, and warns them that, when eating and drinking have become the objects of life, animalization will speedily follow.

"It was thus," he facetiously remarks, "that Circe changed the companions of Ulysses into pigs."

It is certain that the monastic gluttony of Austria, Bavaria, and the adjoining states, where plethoric convents abound, has developed an unmistakable type of grossness in the characteristic physiognomies of those countries. The *ingenium pingue* which Ulric Hutten satirizes is still an hereditary affliction in many Catholic districts, and nowhere more than in Austria proper, in Linz and Vienna, where the art of cookery has become the problem of life, and "the instinct of liberty is drowned in sausage-fat."

Abstinent habits, too, begin to set their mark if continued to the second or third generation. The ascetic vigor of Semitic countenances probably dates from the establishment of the Mosaic and Islamitic codes, with their rigid dietetic restrictions, and something in the spiritualistic eyes of the Arabian desert-dwellers suggests the absence of those animal brain-elements which according to Dio Lewis are assimilated like trichinæ by the use of pork and beef. But only a French *savant* can go so far as to reconstruct the entire national history of a race from such physiognomic indications. "The face of a Turk," says M. de Chateaubriand, "shows the high cheekbones and powerful, bone-crushing jaws of the original Turkoman shepherd, improved by a diet of Attic figs and Thessalian grapes, further sweetened by the sherbet and perfumed cakes of Constantinople, and finally clouded by the fumes of opium!"

"There is a sadness in the face of the typical Chinese," writes the Rev. Mr. Gentz, "which now always moves me to infinite pity. At first they were vaguely repulsive to me, these death-head profiles and sad, sunken eyes, but I can interpret them now, and they speak to me of centuries and centuries of dull, hopeless suffering by slavery, poverty, and loathsome or insufficient food." If we believe that Dr. Fowler was able to distinguish the weavers from other operatives of a miscellaneous manufactory, merely by the formation of their heads, we can not consistently call even Chateaubriand a visionary, for "alimentativeness" is one of the recognized organs of the craniological systems. A certain amplitude of the region between the ear and the posterior base of the skull indicates gormandism to the followers of Dr. Gall, and excessive development, therefore, of gluttony and voracity. A happy illustration if not demonstration hereof is the preserved bust of Vitellius, the imperial arch-glutton, whose enormous head seems only a reduced continuation of the still more enormous neck. Lavater, the father of Physiognomy, describes the "*Fresser-Falte*" or gormand's wrinkle which in his opinion is developed by a certain movement of the cheeks which makes us say, "His mouth waters," and by which he thinks he could detect an Austrian abbot in any disguise.

On the moral effect of sundry articles of food, Dr. Bock, the Leipsic professor, and author of the famous "Buch vom gesunden und kranken Menschen" ("Man in Health and Disease"), discourses as follows:

"Flesh-food imparts courage, but also aggressive moods and bad temper, with intervals of gloom and hypochondria; excessive use of pork can produce a mental nausea, known to the Hungarians as the *Tzömör*, which may lead to insanity and suicide. The ichthyophagous tribes of northern Siberia are rendered stupid and sluggish by an exclusive diet of fish. Fish and fowl in moderate quantities and in combination with vegetable food, produce no appreciable injurious effects. The influence of ripe fruit is benign, exhilarating without the eventual reaction that always follows alcoholic excitement. Milk, too, especially the rich milk of sheep, has an assuaging, mildly cheering effect even on hypochondriacs and dyspeptics. Pure fat of any kind exercises a calming influence on excited passions, but if long continued as an article of diet tends to somnolency and lassitude. Strong cheese operates as a sedative and a check to the activity of the brain-functions—makes us stupid in other words, and can also result in a half-physical, half-psychical dejection not dissimilar to the *Tzömör*.

"Wheat-bread is neutral, a most excellent though not all-sufficient article of food, and, like a blank sheet of paper, serves as a foil to whatever you may combine it with, while sour rye-bread is a tonic and reacts on the temper in a feeble way. Eggs, raw or soft-boiled, are more nourishing than meat, stimulate muscular activity, and produce reflective rather than vindictive moods. Sugar alone, or preponderating in made dishes, causes vague uneasiness in some and merriment and wantonness in other constitutions, but moderately combined with farinaceous substances and fat, is inferior only to fruit as an alimentary corrective. Potatoes and the legumina (beans, peas, and lentils), inasmuch as they are farinaceous, are a legitimate article of food, yet not as healthy as the cereals. They lack the brain-forming elements, and, though like bread they might sustain life, they would operate depressingly—produce weariness and *ennui*, without the addition of saccharine and sub-acid food.

"The nervousness and peevishness of our times are chiefly attributable to tea and coffee; the digestive organs of confirmed coffee-drinkers are in a state of chronic derangement, which reacts on the brain, producing fretful and lachrymose moods. Fine ladies, addicted to strong coffee, have a characteristic temper which I might describe as a mania for acting the persecuted saint. Chocolate is neutral in its psychic effects, and is really the most harmless of our fashionable drinks. The snappish, petulant humor of the Chinese can with certainty be ascribed to their immoderate fondness for tea. Beer is brutalizing, wine impassions, whisky infuriates, but eventually unmans.

"Alcoholic drinks combined with a flesh and fat diet totally subjugate the moral man unless their influence be counteracted by violent exercise. But with sedentary habits they produce those unhappy flesh sponges which may be studied in metropolitan bachelor-halls, but better yet in wealthy convents. The soul that may still linger in a fat Austrian

abbot is functional to his body only as salt is to pork—in preventing imminent putrefaction."

Essays on diet gravitate toward the Austrian abbot, it seems. But the importance of the three daily meals was indeed wonderfully enhanced by the tedium of convent-life. The god *Venter*, Ulrich Hutten insinuates, was ever of more consequence to the holy fraternity than all the saints of the Roman calendar, and the greatest miracle in their estimation is the feeding of the five thousand with five loaves of bread. With few exceptions the abbeys and prebendaries of mediæval Europe were strongholds of gluttony, the well-appointed receptacles of the *viri amplissimi* who carved the board of the dinner-table for the reception of their ample paunches, and whose faces shone at the aspect of a favorite dish as the countenance of Moses on Sinai. Their fasts in Lent were really a satire on the *bona fide* and chronic fasts of the poor; pastry, puddings, and eel-pies in lieu of the normal venison haunches, and butter instead of ham-fat, helped to sweeten the time of penance; and Erasmus mentions the prior of an abbey who instructed his major-domo to reduce the accustomed number of dumplings for the sake of Good-Friday: "Make only ten to-day," said the pious prelate—"but," after some reflection, "you can make them—a little larger."

Of what transcendent interest the bill of fare must have been to Cardinal Dubois, who called on the dying Fontenelle at his boarding-house! The landlord announcing asparagus for dinner, and asking instructions in regard to the desired sauce, provoked an animated controversy between the two dogmatists. Fontenelle insisted on cream, the Cardinal on melted butter, till the landlord suggested a compromise—he would divide the material and use a separate sauce for each half. But Fontenelle was not destined to eat that dinner—his day of life was ended by a stroke of apoplexy before the sun had reached the meridian. Dubois, who had recognized the sad fact with a paroxysm of grief, then rushed to the landing and shouted down the memorable words, "Mettez tous au beurre!"—(Butter-sauce for the whole lot!)

Twenty per cent. of the French revenues were ingulfed by the *cuisine* of Louis le Grand, and other court kitchens have furnished very strong arguments to the opponents of royalty. During the ante-Napoleonic era of small German principalities, more than one of those "commanders of four faithful square miles" astonished the world by selecting a Secretary of the Treasury from his staff of French cooks; but they who wondered did not know what secrets those functionaries could have revealed to a committee of ways and means. Peter the Great, at his departure from Castle Waldeck, where he had been feasted as the guest of the sovereign proprietor for some days, was asked to give his opinion of the château. "Everything is splendid," replied the ingenuous Russian, "only the kitchen is too large."

Such kitchens and their products have often deserved the attention of the historical pragmatist. An indigestible mushroom stew provoked

King Philip's edict against his Protestant subjects and thus caused the revolt of the Netherlands, and the historical eel-pie that extinguished the house of the Medici aided the cause of the Reformation more than all the armies of Sweden and Brandenburg. Mohammed II., the conqueror of Constantinople, we learn from Raumer's history, had an attack of gastritis after finishing a highly seasoned dish of broiled liver. As a matter of course the responsible cook was put to death at once, but the pains and the rage of the Sultan were not appeased, and with his own hand he stabbed Demetrius Phranza, his beautiful favorite, son of the late chief minister of the fallen Greek Empire. By this barbarous act he alienated the hearts of his Christian subjects for ever, and planted the seeds of that hatred which perhaps at this moment bears its harvest on the battle-field of Bulgaria. That dish of sour milk and rye-bread which Charles II. had to eat in his haystack after the battle of Worcester seems never to have been digested by the house of Stuart, though it might have imparted a lesson more useful to the "merry monarch" than any precept of the Scotch Covenanters.

Frederick the Great, who proved himself the master spirit of Europe by such incontrovertible arguments, was himself mastered by his fondness for certain French-made dishes, which, according to Dr. Zimmermann, shortened his life by at least ten years. One of his odes, addressed to Monsieur Noël, his *caterer-en-chef*, dwells rapturously on the merits of a peculiar partridge-pie. "Not, though, as if I doubted that such pies will send me and you *à l'enfer*," Frederick added in prose after reading this production to Noël himself. "I would follow your majesty even there," returned the courteous cook, "and it is a consoling circumstance that neither of us two is afraid of fire."

We have no Roman Pollios who chopped up a couple of young slaves every week to improve the flavor of their carps; but it is said of the Empress Elizabeth of Russia that during her residence in Moscow she caused the death of more than one courier, who had to bring in oysters and fresh sea-fish from the coast within a specified time. Domitian, the impulsive Imperator, once actually assembled the Roman Senate in special session to vote on the merits of a new sauce which he desired to try on a fat specimen of *Rhombus maximus*, the Mediterranean turbot! Ælius Verus, whose administration of Asia Minor had drained the wretched province of all its available cash, spent the produce of his rapacity in less than four years in his voluptuous retreat of Daphne, or in the riots of Antioch, where it is said that a single entertainment, to which only about a dozen guests were invited, cost above six million sesterces, or nearly $240,500.

A cook in those times could often earn a talent ($1,200) a day, which sum, Petronius remarks, would have sufficed to hire a dozen philosophers for a year. It was the age of complete degeneration of the once so frugal Romans, who now tolerated men like Pyttilus, who got an asbestos sheath fitted to his tongue to enable him to swallow the hottest

dishes and spices with impunity; or Aristolenus, who longed for the throat of a crane, that he might prolong the bliss of deglutition. Tacitus speaks of a particular dish, called the shield of Minerva, the ingredients of which cost sixty talents ($72,000), and which the ineffable Vitellius had at different times prepared at that price—an insanity which we may hesitate to believe; but less than a century ago the city of London treated George III. to a banquet of three hundred and fourteen "courses," at an expense of twenty-six thousand pounds sterling.

Opposite the Palais Royal, along the Chaussée d'Antin and on the Rue Rivoli, Paris, there are restaurants where a moderate fortune may be spent in a single week, and the *déjeuners-dinatoires* of the Frères Provençaux are not forgotten where some piquant made dishes would cost more than a year's board in the Faubourg St.-Germain.

"They offered me an *omellette* at Fitchburg," says Henry Thoreau, "an omellette with fried bacon, at forty-five cents. Not having forty-five cents to spare for an indigestion, I bought some bread and butter, which, together with the apples I had, made me a fine dinner. We *do* need some fat and farinaceous substance once a day, but, if one can get it out of a butter sandwich and ten cents, he commits a crime against national economy and against himself if he wastes the fourfold price on an omellette and fried bacon. And why commit a further waste by calling the thing an o-mel-lette? Are not the two syllables of a pancake sufficient?"

Whatever may have been the intrinsic value of that pancake, it would certainly be worth forty-five cents to know what Henry Thoreau would have said about the following *menu* of a "little lunch," given at the Langham Hotel (London) to the members of the Dietary Reform Club (society for the introduction of horse-flesh):

Potages—Consommé de cheval. Purée de destrier. *Amontillado.*

Poissons—Saumon à la sause arabe. Filets de soles à l'huile hippophagique. *Vin du Rhin.*

Hors-d'œuvres—Terrines de foie maigre chevalines. Saucissons de cheval aux pistaches syriaques. *Xérès.*

Relevés—Filet de Pégase roti aux pommes de terre à la crême. Dinde aux châtaignes. Aloyau de cheval farci à la centaure et aux choux de Bruxelles. Culotte de cheval braisée aux chevaux de frise. *Champagne sec.*

Entrées—Petits pâtés à la moëlle-Bucéphale. Kromeskys à la gladiateur. Poulets garnis à l'hippogriffe. Langues de cheval àla troyenne. *Château perayne.*

SECOND SERVICE.

Rôts—Canards sauvages. Pluviers. Mayonnaises de homard à l'huile de Rossinante. Petits pois à la française, choux-fleurs au parmesan. *Volney.*

Entremets—Gelée de pieds de cheval au marasquin. Zéphirs sautés à l'huile chevaleresque. Gâteau vétérinaire á la Ducroix. Feuillantines aux pommes des Hespérides. *Saint-Peray.*

Glaces—Crême aux truffes. Sorbets contre-préjugés. *Liqueurs.*

Dessert—Vins fins de Bordeaux. Madère. Café.

Buffet—Marmalade au kirsch, gâteau d'Italie au fromage de Chester, etc., etc.

The Langham has been eclipsed by some Regent Street club-rooms, if not by Delmonico's, but Paris is still the Mecca of epicures, and even during the Prussian siege Baron Brisse would have undertaken to improve on the above *menu*. Next, perhaps, comes St. Petersburg with its *mislanitza* and caviare-suppers, then London, New York, and the city that derives its name from ham-sandwiches, as Heine suggests.

The champion belt of Apicius belongs probably to Count Luckner, a Russian dignitary of vast estates in the government of Smolensk, and for a time ambassador at the court of Vienna, where he left because Herr Saphire called him an emotional swill-barrel! At his country seat of Ranzow he is said to receive a daily *programme de cuisine* from his major-domo, which he scrutinizes like the plan of a campaign. He is known to have knouted the landlord of a country tavern for using lard instead of butter in a dish of cauliflowers, and once he nearly broke the heart of his favorite cook by degrading him to the rank of dish-washer for a similar offense. "Crying and whining will not mend the matter, sir," he told the tearful penitent; "if you had assassinated your gray-haired father, I might call it a perfectly natural act: but that you combine raisins and pork in the same ragout, you must ask your God to pardon you—I can not!" At a banquet in Vienna he was able to indicate the native country of six different kinds of pheasants, but once created a sensation at his hotel by upsetting his chair and leaving the *table-d'hôte* in a towering passion—they had employed hartshorn instead of yeast in the preparation of a certain variety of sponge-cake!

Berlin has its Jockey Club and a "Hof-Restauration," and in elaborate *soupers* can dispute the prestige of St. Petersburg, but Vienna is too gross in its tastes to deserve a place in this list, though to a Hungarian palate its *gulash* (a ragout of broiled mutton) and *Kaiser-suppen* take rank with nectar and ambrosia. Quantity is prized more than quality here, as well as in other parts of southern Germany or in Bohemia, where forty men of a Prussian regiment could successively impersonate a Bohemian burgher before anything wrong was suspected. During the last occupation of Prague by the North-German troops, the legend runs, there was a grand masked ball at the opera-house, in the lower story of which a regiment of Prussian dragoons had been quartered. Somehow or other the soldiers got possession of a *domino* or complete masquerade suit, representing a fat burgomaster in his official toggery. An adventurous private donned the suit and gained admittance to the *superas auras* of the ballroom, and so on to the refreshment-hall, where his enterprise was rewarded by all the luxuries of the Bohemian season. His return to the guard-room with the tale of triumph caused a bonanza sensation, but discipline prevailed, and the regiment was organized into ten-minute reliefs, who in quick succession stormed the works and performed feats of gastronomic daring which soon drew a circle of admirers around the refreshment-table. In and

out rushed the black domino, returning like Antæus with ever-renewed strength, it seemed, from a contact with mother earth. The burghers of Prague looked on, wondered, admired, and finally broke out into enthusiastic applause—they began to comprehend; it was the consistent, most natural and appropriate acting out of the part which the domino required—the character *rôle* of a fat burgomaster who alternates his official duties with short calls at a lunch-table—and only the fortieth call suggested superhuman powers and an investigation of the mystery.

North America, with all its strawberry short-cakes, clam-bakes, and railroad restaurants, is perhaps, after all, the land blessed with the most natural diet. Healthy food, which is the not-often-used privilege of the rich in Europe, abounds on the table of the poor farmer here. Our five or six largest cities emulate the vice-centers of the Old World, and have not learned yet to sin with grace and long impunity; but the populations of our glorious rural districts, in the valleys of New England, on the Western table-lands, and in the paradise of the Alleghanies, live more faithful to nature than any white men since the days of Cincinnatus, in the golden age of Italy, and in consequence are healthier and healthier-looking than any contemporary race, the peasantry of the Tyrol and the Swiss highlands alone excepted. There we meet our physical superiors; but our inferiority is not hopeless, and if we would just fry a little less and cook more, and substitute milk for coffee, Virginia and Vermont would soon turn out boys to match the prettiest Gemsenjäger of the Alpenland.

Hoeing corn and wood-chopping make a hoecake with bacon or a dish of brown beans more palatable than all the *piquanteries* of the Palais Royal; and even the hog and hominy of the poor tar-heel squatter are preferable to the Irish potato-mess or the cabbage and quass diet of Panslavonia. Exercise in open air as an aid to eupeptic beatitude ranks above all the "old reliable correctives" from the Paracelsian quintessence to Hostetter's bitters. A Persian satrap asked the Spartan ambassador for the receipt of the famous black broth of Lycurgus, but confessed himself unable to relish it without extra spices. "The spices you lack," remarked his guest, "are Spartan gymnastics and a bath in Eurotas."

In Texas, Arkansas, and the Southwestern Territories, we may find habits primitive enough to suit even a Thoreau or an admirer of the patriarchal ages. Abraham treated his angels to a *souper-dinatoire* of roast veal, barley-bread, and milk—more than the Arkansas traveler could count upon at the end of his day's journey. But the air of the prairies, Rocky Mountain adventures, or the vicissitudes of a North Carolina State road can make the homely symposion of a log-cabin as sweet as an evening with Philemon and Baucis.

It has been remarked that the yearning of homesickness is never produced by the recollection of city luxuries, but of rural diet and

habits, and lonely scenery. I am often reminded of an honest mountaineer from western North Carolina who had found a position in the land-office of his State capital. After a session of the State Legislature he was standing among the spectators that always attend the arrival or departure of a Southern railway-train. "Look there, Harry!" said his companion, "there are those representatives of yours again, going to take the cars back to Marion, I guess. Don't they make you feel like taking an up-train yourself sometimes?" "Well, sir," groaned Harry, "I can stand those delegates tolerably enough, but I tell you, if I hear them cry out huckleberries in the morning, it makes me feel like jumping out of bed and starting for home, sweet home, with my shirt-tails flying!"

"Alas," sighs Montaigne, "for my own native hills, and a strawberry-patch, *autour duquel mon âme n'a jamais cessé d'errer!*" May they flourish, the strawberries and huckleberries and the Texas pecans, the peanuts, chestnuts, and maple-trees, and the Chickasaw plums, may they be blessed! Also all johnny-cakes, corn-dodgers, and Tyrolese dumplings, and raspberry puddings, that ever restored health to a stranger or confirmed it to a native! "And above all," says Andreas Hofer in his last address to his countrymen, "beware lest they smuggle in the pottage of Esau with other luxuries of the lowlands; and let your motto be, 'Rye-bread and freedom!'"

BODILY CONDITIONS AS RELATED TO MENTAL STATES.*

By CHARLES FAYETTE TAYLOR, M. D.

WHATEVER that thing, fact, function, or idea which we call mind may be, or whether the brain, as is generally believed, is or is not its sole organ of manifestation, it is universally admitted that varying bodily conditions are accompanied by related variations of mental states. Aphasia, insanity, imbecility, are so often found accompanied by certain definite pathological alterations in the brain-substance that they are generally held to be symptomatic of such local changes. So, also, though in a more general way, melancholia and depression, as well as exaltations and excitements of the mind, are known to depend largely on corresponding general bodily conditions of retarded or accelerated physiological processes.

It is also held, though in a less definite manner, that the health of the body may be affected, beneficially or injuriously, by certain states

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of the mind, as of hope or despondency. Or, more in detail, medical men have observed that certain mental states affect certain functions in certain definite ways. As, for instance, sudden anxiety, as of the non-arrival of a friend when expected, may cause an increase of the peristaltic action, while prolonged anxiety is apt to cause the contrary effect. Joy over good news or at the return of long-absent friends diminishes gastric secretion and causes loss of appetite. The feeble hold on life of the suicidal, and the surprising recoveries from serious diseases and after apparently fatal injuries, in persons whose mental characteristics are hopefulness and determination, are often-recurring facts, familiar to all.

The nature of what we call mind and its relation to the functions of the body is a very wide field of inquiry—too wide, indeed, for our present consideration. But having had unusually favorable opportunities for observing certain phases of psycho-biological relations, I ask your attention while I present some studies which may help us, possibly, to arrive at more practical results, through more satisfactory explanations of certain phenomena, than we have hitherto possessed. So, without further preface, I will introduce my subject by giving a striking example of the influence of a simple mental impression as distinguished from and as independent of thought, will, or consciousness in controlling the manifestation of function.

In September, 1876, I received a letter from a prominent physician living in a Western city, saying that he, in connection with two other medical men, had been treating, unsuccessfully, a case of ununited fracture of the left thigh-bone ; and he inquired if I thought I could do or suggest anything which would lead to its union. The result of some correspondence was that, a few weeks afterward, in October, the patient presented himself with his father at my office.

The case was briefly as follows :

Two years before the young man had met with an accident, and had broken his thigh-bone just above the middle. The family doctor proceeded to set it and apply the proper dressings. In due course of time the fracture united, and the patient got about with some shortening of the limb, and walked with perfect facility for one year, when, in crossing the street, he fell and broke the same bone again about four inches, so they told me, below the seat of the former fracture. Neither of the physicians who had attended him on the previous occasion being in the city, a third medical man, a surgeon of national reputation, was called, who proceeded to apply the proper bandages for fracture. After that the three attended the case conjointly, but no union of the fracture could be obtained, they said, though every usual means had been exhausted to secure it. Such, in brief, was the case as it was presented to me. A careful examination revealed two facts. The first was that there was no ununited fracture, and the second was that the bone had not been broken at the second accident. He was a well-grown, finely formed,

intellectual young man of about sixteen, and he came in on a single crutch, with the left or affected limb swinging limp and wholly useless, and when I laid him on his back, and took hold of the leg to examine it, I found it utterly resistless to every motion. The muscles were wasted, soft, and without tonicity, and, there being a large outward bending in the middle of the bone with lapping of more than two inches, it would roll about, when touched, like a crooked stick on the floor, and it was almost impossible to keep it still long enough to make a diagram. The attenuation of the soft parts was so great that the bone was easily examined, and no line of union or the slightest evidence of callus being felt at the seat of the alleged second fracture, and being assured that one of the remarkable things in the case was that there had never been any callus, I concluded that the bone had not been fractured at the last injury. There was no doubt that an unfractured bone had been hastily put in splints, and for a year, and up to that time, three eminent men had been devising and using various splints for securing apposition of a fracture which did not exist. That it did not exist is proved by the fact that three days after his arrival he was walking on that leg.

The explanation of this case is exceedingly simple : he *thought* he had refractured his femur at the second accident. This impression caused him instinctively and quite unconsciously to withhold muscular action in that limb—that is, he did what he ought to have done if the limb had been fractured. It was the completeness of the control over the muscles, the utter restraint of all muscular action, causing the totally relaxed and powerless condition, which was mistaken for a broken bone. Of course, the trouble was purely mental. But it was not a condition of mind of which he was in the slightest degree conscious. He was not aware of the fact that he was restraining the muscles from acting during this long time ; so effectually restraining them that all spontaneity was destroyed by a direct and positive effort of the will. He held his limb in a mental vise of such force and persistency that its nutrition was interfered with, and it was wasted to the last degree. And yet he did not know it. There was no shamming. His condition was a great distress to him. He was also at an age when male persons are the least liable to morbid sentiments. At any rate, I could find none in his case. A mere explanation of his condition was not sufficient to enable him to relax his mental hold on the limb. The mental *impression* subordinated his will and the ordinary desire. His treatment consisted in providing situations which would assist him to *let go* of his leg. I caused him to take certain violent exercises with his upper extremities. The intention was to make them so violent that his whole attention would be required for the upper, and there would be none left for the lower extremity. The plan succeeded. Within three days he gave up restraining the limb—let go of it ; in fact, spontaneity was restored, and he began to walk ; began involuntarily, and

without being conscious of it, as he was not conscious of restraining it at and after the second injury.

In this, as in all such cases, accepting by the patient of the opinion that the power exists, is not sufficient to restore the member to use. It is very important to secure the intelligent coöperation of the patient, and instructing him by careful explanations goes far in assisting to arrange the circumstances which tend to restore the normal condition. But simply to know and understand the mental nature of the case is not enough to establish control, because it is not the intelligence principally which is at fault, but there is a modification of what may be called mental *timbre*, coloring the thoughts and all mental operations, which, in my estimation, is the quality with which we have to deal in this class of phenomena. Dr. Elsberg has used the word *timbre* to indicate the quality of a compound sound, and I use the word in an analogous manner to indicate a certain quality of the mind as a whole, as distinguished from separate mental attributes. Further illustrations will make this quality of the mind perfectly clear, as well as show that it is through this *timbre* that the mind makes its potent impressions on the organism.

A young lady was brought to me six years ago for what was supposed to be paralysis of the left lower extremity. She had lost the use of that limb eighteen months before, and, since that time, she had got about entirely on crutches. I immediately recognized the mental character of the affection, and adopted the following plan in order to differentiate between the conscious and the unconscious volitions: After a preliminary examination the day before, I called at her room while she was lying on the bed. Requesting her to remain lying, I engaged her in conversation with the intention of absorbing her entire interest. In this I so far succeeded that when I put my hand below her right foot and began to force it upward, she only remarked that that was the wrong limb, and immediately returned her attention to the story I was telling. When I had pressed it upward enough to bend the knee, I asked her to stretch it down again, which she did, repeating the movement several times without paying any particular attention to what I was doing. After making several pretty vigorous efforts to straighten the limb against some resistance from my hand below the foot, I quietly seized the foot of the affected side, and thus both feet were carried upward together, coming down together also. After several such movements, I began to feel distinct muscular action in the affected member, and, after it had become somewhat vigorous, I quietly let go my hold on the well foot, after which she continued to draw up and push down the affected limb as vigorously as she had just before done with the well one. I was successful in holding her attention to my story, so that she had at most but a dim consciousness, if any at all, of what I was doing. I then recalled her attention to her lower extremities, and requested her to push the left foot down, after I had pushed it up, but she could not make the slightest motion with it.

I say she *could* not, because, though there was power in the muscles, there was no consciousness of power, and thus there could be no volition.

The plan of securing an unconscious volition is often very useful and sometimes indispensable in determining questions of diagnosis growing out of mental influence over function. The following incident occurred within the last few weeks: A young lady nineteen years old was sent to me from Albany for what was supposed to be partial paralysis of the left foot and ankle. She had been affected during the past three years, and was so far disabled that she could not walk more than a block or two without danger of falling, and she actually did fall very frequently.

The exciting cause, or that which called her attention to her foot, was the alleged slipping of the tendon of the peroneus longus muscle where it passes under the outer ankle-bone. She had no theory, fancy, or any other sentiment regarding her lameness whatever. She simply dropped her toes when walking, and was obliged to lift that limb very high to advance the foot and prevent stumbling. When, in examining her, I asked her to raise the foot, she was unable to do so. The muscles moving the ankle-joint were powerless. She was very simple-minded, and would try to do whatever I asked of her. So, making an excuse to get off her shoes and stockings, and keeping her attention while gradually working myself across the room, I suddenly asked her to come toward me, being careful to keep her eyes on me instead of her feet. The floor is of hard wood, and without covering, except a bear-skin rug in front of where she sat. The hair tickled her feet, and she came to me with toes elevated and walking on her heels. I then called her attention to the fact that she had bent her ankles to keep her bare feet from contact with the floor, and asked her to bend them again while looking at them. But she could not do it. I found means, however, to relieve the mental impression which interfered so effectually with the autonomy of locomotion, consciousness of power in the affected foot was restored, and, after having been lame for three years, she went home, within ten days, in a natural state.

But unconscious mental interference with the muscles is to be seen not only in loss of muscular power. Increased muscular action, simulating muscular spasm, may have a mental cause. This may be illustrated by a case. In the spring of 1864 a lady, about thirty-eight years old, unmarried, presented herself with a lame shoulder. Three weeks before, as she raised her right arm to turn the slats of the shutters, she felt a sharp pain in the shoulder. It may have been due to a somewhat energetic contraction of certain muscular fibers, such as most of us occasionally experience without any impression being left on the mind, but which in her case left a lasting effect.

I did not understand the true mental character of the difficulty, and the consequence was, that I got into a great deal of trouble before I

got through with the case. But it was all the more instructive on account of my ignorance, as will be seen in its relation; so I give the case more in detail than is necessary in most of these illustrations.

I found her with the right shoulder drawn forcibly upward, firmly fixed in that position, and very sensitive to handling. Supposing that it might be a sprain, and not wishing to treat such cases, I recommended her to apply to the late Dr. E. R. Peaslee, which she did. One year from the first visit she reappeared in a very sad plight indeed. I found the shoulder drawn up still higher than before, and so firmly fixed that the elbow could not be removed from the side of the body more than three or four inches. She looked haggard and worn out, and she reported her sufferings as having been and being very intense. The history intervening between the two visits was, that Dr. Peaslee had given her some liniments, and, after a while, seeing that she did not regain the use of her arm, he sent her to a professional "rubber," who had used a great deal of disagreeable, violent, and painful manipulation. Finding herself becoming steadily worse, at the end of a year she had returned to me. I immediately sought Dr. Peaslee, and together we made a new examination. We found the large pectoral muscle shortened and enlarged to twice its natural size, and the arm so firmly bound down that it was with difficulty that she got her clothing on. After several consultations, we resolved to etherize her and endeavor to stretch the shortened muscles. The plan was, to make an apparatus which should hold the muscles we were to stretch, under ether, in an extended position, for a certain length of time, and thus relax them. The operation was accordingly performed, and all the force consistent with safety to the bone was used, but without appreciable effect in relaxing the great pectoral muscle. The operation was therefore abandoned as a failure. We then considered the propriety of dividing the tendon of the great pectoral; but, as that was a novel suggestion, a consultation was called, Dr. A. C. Post, of this city, and the late Dr. Alden March, of Albany, being the surgeons selected.

The lady had come under the influence of ether with difficulty, and was very much prostrated by it; so that it was over one month after the attempted stretching of the muscle before the consultation was held at the lady's house in Brooklyn. The lady was still in bed, but, after explaining the case, she was got up, when, to our utter astonishment, we found the muscles completely relaxed and the arm perfectly free to move in every direction. Exactly three years after these events, this lady's brother called on me one evening, saying that he had just made an appointment with Dr. Peaslee—who was on the eve of starting for Europe—to meet me at his sister's house the next evening for the purpose of operating on her other arm, which had in the mean time, he said, become affected precisely as the right arm had previously been. It had been affected for a year, but his sister had kept the fact to her-

self, and it had only come out when she could conceal it no longer, the arm having become useless. Supposing that, somehow, the first operation had been the cause of the cure, we repaired to the house as requested, and, after Dr. Peaslee had etherized her, I operated by stretching the contracted muscles. I found the shoulder in much the same plight as the other had been three years before, though the muscles were not quite so rigid, and I could overcome them without much difficulty. But the shoulder-joint had been held in an immovable position so long that the articulating surfaces had become united by bands of fibrous adhesions in various places, and the snapping of these adhesions, as they were torn asunder when the arm was moved about in different directions, made reports which could be heard at a considerable distance. But the muscles were completely relaxed by the operation, motion was restored to the joint, and we congratulated ourselves on having made no mistake and having had a successful case this time. Thus she was left—Peaslee going to Europe, and I about my business. Just one month afterward I was requested to visit the lady. I found that she had been prostrated by the anæsthetic as before, but that her arm and shoulder were in exactly the same situation as before the operation. Not the slightest benefit had been experienced from it. The shoulder was drawn up and immovable, the arm was held firmly to the side, and that extremity was entirely helpless and useless.

It was evident that the mystery of the case had not been fathomed, and I requested her to come to my house so that I might study it. To this suggestion she readily assented, and for the next few weeks I was vainly striving to find remedies for a state of things which I could not comprehend, and to locate a disease which had no existence. At the end of a month, and after calling a well-known surgeon to my assistance without avail, I resolved to try another operation by *force brisée*. Laughing-gas was being used in minor operations at that time, and, as ether made her so very sick, I resolved to use the nitrous oxide. This was administered twice with an interval of four days, when the muscles relaxed, motion was restored to the shoulder-joint, and there has been no recurrence of the condition described during the intervening thirteen years. A case precisely similar to the foregoing was brought to me two years later.

Still under the impression that the force used in the former case had, in some mysterious manner, been the means of cure, and concluding that nitrous oxide was the most favorable anæsthetic, I set to work to cure this case according to such views. After seven entirely successful operations there was not the least improvement in my patient, and I concluded that I had again mistaken the case. I kept her under observation several months, attempting various means, experimentally, which were of no avail, when, on a careful review of this and many other similar cases, I at last came to the conclusion that the whole difficulty was mental and only mental. Having settled the question of

diagnosis, I sought an interview with this lady and explained my views to her. In plain language I told her that she was holding the arm down by direct though unconscious volition, and that all she had to do was to let go her mental hold on the muscles controlling the movements of the affected shoulder. At first she was a little startled, but I told her to think of it overnight and tell me in the morning if, with the aid of my explanations and the facts of her own and other cases which I related to her, she would not arrive at the same conclusion. She returned the next day, saying that she was convinced that I was right; that she was sure that, through dread of the pain which she anticipated, if she allowed the shoulder-joint to move, she was holding it by main force. She knew and believed all this, but still she had not the power to relax her mental hold on the muscles of the shoulder. To assist her in this I adopted the following plan: I caused her to recline in an easy position, while I stood behind her and took both her hands, the arms bending at the elbows. I made not the least traction on the hands, but simply held them for the purpose of directing and controlling her attention. My requirement was to raise both arms into the upright position, that is, to extend the arms over the head, but not to raise the right, which was free, any faster than she did the left, which she was holding down in close contact with the body. The object was to cause her to give her attention to and absorb her thoughts and interest in the right and unaffected arm, so as to enable her to relax her hold on the left and affected shoulder. The expedient was successful. She did let go her arm, and within a week she had entirely relaxed the muscles about the left shoulder, and regained complete use and control of the previously rigid joint.

I have seen every joint in the body relaxed or stiffened by mental influence, often disastrously so when no aid came to them—sometimes relaxed and stiffened by turns; but I introduce illustrations from cases where these peculiar manifestations have happened at the shoulder, first because they are typical cases, and secondly because I fancy they might be more likely to escape the possible suggestion that, after all, there might have been some organic lesion involved in the cases. We certainly do have the same mental influences complicating organic diseases of the joints. But my object, at this time, is to exclude such cases as can justly be subject to such an imputation. Of course, after once understanding the true condition of things, it is easy to see that the only influence of the respective operations of *force brisée*, in these cases, was on the patient's mind. In the first case, while she was lying weak and prostrate from the effects of the anæsthetic, she forgot her shoulder and simply let go of it. That was all. In the next operation, three years afterward, on the other shoulder, there was less novelty calculated to engage and keep her attention, and the rupturing of the adhesions which had sprung up in consequence of prolonged loss of motion was sufficient to maintain her interest in the joint, so that her attention failed to be

diverted. But the circumstances attending the operations with the laughing-gas were again calculated to absorb the attention in other directions and thus divert it from the shoulder. The result was the immediate relaxation of the muscles involved in maintaining the shoulder in a fixed position. In the absence of any local disease which could cause local irritation and reflex muscular contraction, this must have been kept up by direct volition. An important evidence of its voluntary character, besides that which is afforded by the prompt relaxation through opposite mental influence, was the immediate and very great improvement in the patient's general health. She was, in fact, completely exhausted by a labor which she was not conscious of doing, but when she ceased this continuous effort she at once improved in strength. The same improvement in the general health, but in an even more marked degree, was manifested in the second case above related.

Adult life is not alone liable to the class of mental influences which we are now discussing. Young persons and even quite small children are frequent subjects for psycho-biological study.

But mental influence over bodily function is exhibited not alone in connection with the muscles in determining their relaxation or rigidity, in certain cases; but what are called bodily sensations are even more dominated by the mental timbre of the individual. We have local and general hyperæsthesias and anæsthesias both as transient and as permanent conditions from this cause. I feel obliged to employ phrases as they are employed in common use, but, strictly speaking, there are no bodily sensations, for all sensation is mental—there is and can be no other. The most that we can strictly say is that we feel in the mind, but refer the cause of such feeling to certain locations in the body. Stick a pin in my flesh, and whether I feel it or not, and how much I may feel it, will depend wholly on the state of my mind. If obscured by an anæsthetic or if asleep, provided the impinging on the nerves is not sufficient to waken me, or even if my attention be very much absorbed, I shall not be conscious of the pricking. On the other hand, if I have been pricked before so that my fears are aroused, or if I am worried or weary or ill, then the pain is many hundred times greater than under the opposite circumstances. We go to a dentist one day when we are in a hurry, and with the mind troubled about some matter. The drilling of his little instrument is agony. We leave and return the next day with plenty of time, and our business settled. The dentist drills still deeper into the same cavity while we sit in comparative comfort.

But not only the same person has different degrees of sensation at different times, according to his mental timbre at the time, but different individuals and different classes of persons feel both pleasures and pains more or less according to their individual or class elevation in the intellectual scale. If a knife were thrust into the flesh, in corresponding locations and to the same depth, in twenty people, no two would feel

the incision to the same degree, and the difference in sensations would be simply the difference of mental constitutions, that is, it would be wholly mental. So of classes. The child of the widow, Bridget Murphy, who lives in a back alley and goes out to work by the day, leaving her children at home with nothing to stimulate the mind, does not feel the same amount of pain from the pressure of an instrument which is applied for disease of the hip-joint, which he has got in falling down stairs, as the child reared among the excitements of a cultivated home, with pictures and toys, the circus and menagerie, dogs and horses, and the society of cultivated adults to stimulate mental activity. While the widow's son can hardly talk at five years old, the other, by aid of French and German nurses, speaks three languages at the same age. But when he falls on the ice and gets hip-disease, his sufferings correspond to his mental rather than to his bodily condition, and his pains, like his pleasures, are as much greater than those of the first-mentioned child as his mind is more active and thus more susceptible. To continue the illustration, the instrument worn by the child intellectually low down may, by the mother's ignorance and neglect, become buried in the flesh, with slight murmur, compared to the distress caused by a crumb of bread or a wrinkle in the linen under the points of pressure in the mentally active child. Mental susceptibility corresponds closely with mental activity, so that so-called bodily sensibility must correspond closely again with mental activity. And we find this to be the case. What is said to be Indian fortitude, when they tear their flesh in some of their rites, is simply brutishness. They do not feel in the same degree that we should under the same circumstances. And, on the other hand, the cultured and æsthetic should comprehend, more than they do, that an increased capacity for painful sensations is the direct result and the constant accompaniment of the refinements of civilization, and that to suffer is inevitable along with the pleasurable emotions, which constitute at once the compensation and the charm of the higher civilized existence.

An illustration or two of the mental production of hyperæsthesia —and it is the same with anæsthesia—will suffice for this part of our subject.

It should be remembered that each case represents a class of cases, and is not simply an isolated and phenomenal instance of a curious manifestation. Many cases of lameness of the ankle-joint are produced by, or, strictly speaking, exist only in, the mind, as, for instance, the following among many others :

An unmarried lady of thirty called on me for advice with reference to a foot and ankle which she had not been able to use during the three and a half years preceding. There was a history of some slight injury, with periods of improvement during the first six months of her lameness, but with a final loss of ability to use it on account of its exceeding painfulness at every attempt to bear her weight upon it, and she had been

for that length of time on crutches. The foot and ankle were very thin, cold, and clammy, and even very gentle manipulation caused considerable pain. I could not make out, from all the history which I could gather from the lady herself, with the help of her sister, who accompanied her, that the so-called injury had been at all serious, and I concluded that what had been supposed a serious injury to the ankle had simply been a circumstance which had established a condition of apprehension in regard to that locality.

A careful examination satisfied me that the lameness was in the mind, referring to the foot and ankle, but without any sufficient injury of the parts referred to to cause lameness. It was therefore the mind rather than the foot and ankle which ought to be treated, and it was the mind which I did treat, with success. There was no excessive fear here, as there is in many cases, but simply pain on using the foot. Of course there was the misapprehension with regard to the nature of the case, and correcting this misapprehension was one important element in treatment. But such correction only put her *en rapport* with her treatment, but did not alter the fact that it *did* hurt to bear weight on the foot. In such cases it is important to give some time for the emotions to adjust themselves to what the intelligence accepts on the subject. In the mean time something was given her to do, some uses of the foot which would fall far short of attaining the point of pressure or motion which her experience had shown would or might be painful; that is, she was required to never approach the point where she had been accustomed to expect to be hurt. Thus the element of expectancy was gradually lessened, and finally eliminated entirely, so that in a few weeks she could walk as well as ever. This was twelve years ago. She has never had a relapse, and is perfectly well to-day. This is one of the classes of cases out of which the so-called "bone-setters" make so much capital.

The foot, ankle, knee, and hip joints are all frequently referred to when there is no organic affection at the point indicated by the mental impression, and I might go on almost indefinitely relating instances, if time permitted. But it may be sufficient to indicate the frequency of disturbed psycho-biological relations to say that I estimate that not less than one half of all cases applying to me for relief from joint affections belong to the class under discussion.

Before leaving this aspect of the subject I think I ought to mention the case of a little girl living in Williamsburgh, who, when she was about three years old, saw a very lame child in the street one day, a patient of mine, and when she returned home her family were surprised to find her lame. The patient the child saw was affected by paralysis, but, curiously enough, the child's lameness simulated disease of the hip-joint. Paralysis could not be well imitated. I was consulted some two years after the first appearance of the lameness, and her attending physician, the late Dr. Brady, of Williamsburgh, gave me the history of

her case and the treatment which he had pursued. I had pronounced the lameness mental before I knew of the circumstance which this physician related to me. A surgeon celebrated as a joint-doctor was consulted soon after the lameness was discovered, who pronounced it a case of hip-joint disease. She was treated by confinement and extension, the weight and pulley being used for the latter purpose. The limb, which had been drawn up very much, quickly came down to its natural position, and, after three months of this treatment, finding everything right, no pain on motion, the limb straight out, etc., the case was considered cured, and the doctor asked some of his friends, brother physicians, to see her put on to her feet and attest the remarkable cure. So, after they were assembled, the bandages were taken off and she was put on the floor and told to walk across the room. "You can imagine my surprise and disgust," said he, in telling me the story, "to see her go across the room with the leg drawn up precisely as it was before, and without any change whatever in the amount of deformity or her manner of walking." This child has been brought to me from time to time during the past twelve years, but I have always refused to accept the case as one of disease of the hip-joint. Just one year ago I examined her for the last time. She was then fourteen years old, and anxious to get her leg down. It had been drawn up since she was three years of age. The hip-joint was in perfect condition, and the only reason why she couldn't walk as other persons do was the shortening of the flexor muscles due to the persistent, drawn-up position. The growth had been retarded somewhat, because it had been used less forcibly. But no injury had been done to the hip-joint.

This child was so young when the affection first appeared that it was never made out what were the particular sensations which influenced the volition in the way they did.

It is necessarily more easy to get demonstrations and illustrations of the various influences of the mind over the sensations and the voluntary muscular actions than of the involuntary processes of life. But it must not be supposed that sensation and motion are alone influenced or dominated, as the case may be, by mental states, for it is possible that involuntary processes are even more under the same influence. To a certain and very positive extent they certainly are. To merely mention the phenomena of blushing, pallor, palpitation, shivering, sea-sickness, etc., suggests effects on the involuntary functions which are so common as to be almost overlooked in enumerations of kindred examples. But that the influence of certain sentiments on certain involuntary functions is very potent and positive is well illustrated in the following case:

A lady friend of mine had for some years been speaking to me, as I met her socially from time to time, with regard to the condition of one of her daughters. Otherwise a healthy young lady of about twenty-four years of age, she had had, all her adult life, the one trouble of inveter-

ate constipation. The most powerful medicines in exceptionally large doses failed to produce more than the most meager effects, until at last her condition became alarming. At this juncture they put her under my direct professional care. But nothing that I could do seemed to have the slightest effect on her in ameliorating her condition. As she lived in my family, I had every opportunity to observe her, and after a while my attention was attracted to the fact that, in making my inquiries as to how she felt, she never seemed to know anything about it. In fact, she would deny having any sensations of any kind whatever. I would sometimes see her, while in the family circle, put her hand to her back or to some other part of her body, acting as if she had a sharp pain there. But, even when I made immediate inquiries, she would invariably deny that she had felt any pain whatever. At length circumstances supervened which made me positive that conditions existed which, in any ordinary person, would cause the sensation of pain. But she denied any such sensation. At last, after three months of fruitless effort to relieve her, I made up my mind that this was a case the reverse of the more common result of civilized existence. Her mind, instead of being too firmly centered on some organ or function, was too much withdrawn from the ordinary phenomena connected with existence. In a word, she was suffering from not perceiving, and thus not knowing and heeding, the natural monitions. Having come to a correct diagnosis of the case, I explained very carefully all the facts, and gave her minute directions calculated to assist her in fixing and keeping her attention upon her bodily functions till they should respond to the mental stimulus thus restored to them. The result was that, within two days, by the mere change of sentiment regarding a certain function, that function, which during not less than fifteen years had been wellnigh suspended, was immediately stimulated to full activity. I impressed her mind with the belief that certain results would happen by following the directions which I gave her for the purpose. This was eleven years ago, and this lady told me only a few months ago that she has remained in perfect health, so far as the function in question is concerned, during the whole time.

Heretofore I have adduced such cases only as were clearly uncomplicated with organic disease, and generally where there had been some exciting cause to determine the special location of the mental interference.

When I say "exciting cause," I mean, of course, some circumstance or event which is calculated to fix the attention and make a mental impression. But, in the majority of instances, no such "exciting cause" is traceable. It generally simply happens that the subject finds himself with certain abridgments or apparent exaltations of the purturbed function, without being able to trace the event which determined the character and location of the mental influence. It is highly probable that in most cases there have been circumstances which have

led directly to the result as seen, but which have made no impression on the patient's memory. Still, it seems probable also that there may be mental influences excessively manifested over particular organs and functions, which are determined by purely subjective causes and without the intervention of external circumstance. Be that as it may, it seems to be necessary that there should be a certain preparation—a sort of condition precedent—in the mind which makes it liable to abnormal manifestations. Mental influence over bodily function is in itself a constant and therefore a normal condition of existence. But one of the products of civilization is to exalt the mental into a too preponderating influence. In that exaltation the mind easily becomes hyper-susceptible. It takes on, with abnormal facility, a timbre of which it is not itself conscious, but which tends to modify biological relations in the way, among others, which I have to a certain extent illustrated in the preceding pages.

Now, there are various circumstances which favor modifications of psycho-biological relations, but which do not themselves directly cause them. Among those most frequently coming under professional recognition, hysteria may be instanced as a potent influence; but, in the light of the facts in my experience, it is incorrect to speak of the hysterical foot or the hysterical stomach or knee. We have the phenomena exhibited in both sexes, in children of tender years and in men and women in advanced life. Hysteria, or, more properly, imperfect sexual hygiene in both male and female, by perturbing the system, does produce a condition favoring modifications of the mental states; but the phenomena under consideration are not themselves hysterical. Any thing or any influence—and they are many—which can increase the mental tension and impressionability beyond a certain normal standard, will produce a modification of the timbre such as we see exemplified in so many instances. Besides the peculiar cases given as illustrations, there is a large class of what are called "simulated diseases," persons with local sensations or pains which do not arise from or represent corresponding local diseases. These can not have even a passing allusion here. Time also prevents me from entering into a discussion of the important subject of mental influence on actual disease, even if that aspect of my subject did not more properly belong to the medical department of biology. Suffice it here to say that, as must be inferred from the facts and arguments already adduced, no system of therapeutics can be complete which does not embrace the design of controlling psycho-biological relations in general, and with reference to chronic disease especially.

From the foregoing presentation, several important and practical deductions may be drawn:

1. Mental culture, while it brings more physical pleasure, brings also increased bodily susceptibility.

2. Pain, at least that which we are now considering, is but an in-

creased degree of sensation, which, in ordinary measure, is either not noticed or pleasurable.

3. Sensations called pains should not be mistaken for, confounded with, or be considered the measure of disease, even when accompanied by it.

4. All sensations, including unpleasant sensations or pains, represent mental qualities only, and these always correspond, no matter what the exciting cause, with the capacity of the mind to be impressed; that is, with its rapidity and force of action.

Lastly, the individual is generally incapable of correctly estimating the subjective value of his own sensations, whatever character they may assume.

Intimately connected with, and in fact growing out of, the subject of the influence of mental timbre over the functions of the body, are many interesting questions of mental ethics which, it seems to me, ought to be studied from a somewhat different point of view than that from which they are commonly regarded.

As we have seen that bodily functions may be profoundly modified under unconscious mental influence, so it will be found, when carefully analyzed, that the product of the mental operations themselves may be likewise modified, under peculiar subjective influences, without arousing the consciousness. In a word, the mind may be in a condition of what we may, illustratively, call *mental allotropism*, during which the laws ordinarily controlling mental operations seem to be reversed, with corresponding products of intellection.

A case in point is now attracting altogether more attention than it deserves, or would receive, if properly understood. It is stated in the newspapers that there is a young lady living in our neighboring city of Brooklyn who, among other surprising things which she does or omits to do, has not eaten any food or taken any nourishment during the past nine years. It is claimed, on the one hand, that this lady is a perfectly truthful person, with a highly endowed moral sense, intelligent, kind, benevolent, and shrinking from notoriety, and that her statements ought to be taken as conclusive in regard to the facts. The absence of any motive for propagating an unprofitable, ridiculous falsehood is held as confirmatory of her allegations. On the other hand, it is as stoutly maintained that she is an arrant impostor, whose sole purpose is to acquire a transient notoriety; and the non-acceptance of various tests, proposed to substantiate or disprove her statements, is adduced as evidence of the fraud attempted. Now I think we shall see that, in the light of inferences from what has preceded, neither party to this controversy is wholly right or altogether wrong. While it can not for a moment be admitted that a person can live nine years, or any number of years, without food, yet it would be contrary to related facts, and illogical, to assume that she intends to deceive. It is quite within the possibilities that this lady believes that she does not eat. And yet she

must necessarily take food. There can be no doubt of that. Let us draw a few parallels, and see how easily such cases are explained by very ordinary and accepted facts. Every physician has had cases of persons who asserted that they did not sleep at all for long seasons at a time, while the fact was that such persons did actually sleep a good deal, as proved by being seen asleep, and by the fact that they did not suffer in health, as they must have done if sleep had been entirely absent. But these persons, while asserting that which was not true concerning an important matter, did not intend to falsify. They simply stated what they believed to be true. Their mental condition was such that they did not feel the impression which sleep ordinarily makes on the consciousness. They slept, but, having no impression of sleep, they asserted that they did not sleep. They could not, with the only evidence which they possessed, the absence of any mental impression of having slept, assert otherwise. There are other persons who, under certain states of mind, say that they eat almost nothing at all—"not enough to keep a bird alive"—while, as a matter of fact, they do eat very well, sometimes even heartily. We see them eat enough to maintain them well nourished, and yet they assert that they do not eat enough for the bodily requirements. Again, the difficulty lies, not in the fact of eating, nor in any desire to falsify, but in the fact that, in their peculiar mental condition, their eating, though seen by others and by themselves, makes no impression on their minds. They state, not what is true, but what they *feel* to be true. To recur to the more typical class:

A lady, who was at once the daughter of one physician and the sister of another, lost the use of one limb soon after a slight attack of sore-throat. She got about on crutches for nearly a year, and when summer came she went into the country, where she grew stout and was in perfect bodily health, joyfully anticipating a speedy return to her home in the city with restored powers. But suddenly the other limb gave out, and she was brought helpless back. After I had examined her I knew that she had all the power in her limbs which she had ever had, but that did not make me think that she was intending to deceive me when she asserted that she had no power to stand. Her statement was contrary to the fact, but she had to express that which she *felt* to be the fact. The parallel goes even further than this.

This person did use her limbs more or less in certain ways, and under certain circumstances. But that fact made no impression on her consciousness, as against the stronger impression of entire want of power in her limbs. And so it is in all of the cases of perverted and abnormal mental timbre, when this condition has passed a certain boundary. The words spoken and the things done are dominated by the paramount influence on, and take their quality and coloring from, the predominating mental state of the subjects of it.

Nevertheless, while the mental timbre is an independent condition,

it does not prevent the introduction of moral qualities also. A person may lose the use of a member, for instance, through loss of consciousness of power in that member, and at the same time she may have so much pleasure in the sympathy which the disability excites in those around her as to prefer to be lame or bedridden. Confinement, from any cause, is more apt to be demoralizing than elevating, at the best, and it is not strange that a certain number of bedridden cases should, more through the ignorance and want of tact of those around them than original desire to deceive, form the habit of, first, making the most of their infirmities to increase sympathy, and, finally, come to exaggerate and to falsify; thus they pave the way to becoming the instruments of their own and others' craving to be considered phenomenal. And it may well be, and circumstances seem to establish, that the Brooklyn case alluded to has arrived at that point now. I only insist that it is not logically necessary, in similar cases, to assume intentional deception from the beginning, nor, in many cases, at any time can this be rightfully asserted.

It will be observed that I have not used the word "imagination" in connection with the phenomena under consideration. I have not used that term, because it does not apply to the facts. Imagination is an attribute of the mind, an important but wholly distinct mental faculty. But it is not the whole mind, neither does it represent a special condition of the mind. The imagination is often given full play in many of these cases, and undoubtedly assists in producing that mental state which ultimately ends in mental allotropism. But, however conspicuous the imagination may be in such a case, its only importance consists in being one of the many factors tending to produce a certain definite result, which, when reached, is not imagination nor the direct product of the imagination. I speak of this because I think a great deal of harm has been done by the use of this word. It is employed, generally, as if the use of it carried some explanation, and it is understood by the subjects as casting some imputation. Besides, abnormal mental timbre, productive of positive effects on the organism, is quite as apt to be manifested in certain wholly unimaginative persons as in the imaginative. The most marked cases which have come under my observation have been those of persons whose characteristics have been strong common sense and self-forgetfulness.

NEW GUINEA AND ITS INHABITANTS.

By ALFRED RUSSEL WALLACE.

II.

THE houses of the New Guinea people are somewhat different in different localities, but the most general type is that found at Dorey Harbor. There is here a considerable village of large houses built on piles in the water in the usual Malay style, and houses similarly raised on posts (but loftier) are found on the hills some miles inland. Each of these houses is large and accommodates several families, and they are connected by continuous platforms of poles and bamboos, often so uneven and shaky that a European can with difficulty walk on them. A considerable space separates this platform from the shore, with which, however, it is connected by narrow bridges formed of one or two bamboos, supported on posts, and capable of being easily removed. A larger building has the posts carved into the rude forms of men and women, and is supposed to be a temple or council-house. This village is probably very like the pile villages of the stone age, whose remains have been found in the lakes of Switzerland and other countries. Similar houses are found in the Aru and Ké Islands, in Waigiou, and on the southwest coast; and they are also common on the southeast coast, sometimes standing in the water, sometimes on the beach above high-water mark. These houses are often a hundred feet long, and sometimes much more, and are occupied by ten or twenty families. On the Fly River similar large houses occur, but only raised a foot or two above the ground; while at the mouth of the Utanata River, on the southwest coast, a large low house was found a hundred feet long, and only six feet wide, with nineteen low doors; but this was evidently only a temporary seaside habitation of a tribe who had their permanent dwellings inland.

Finding these large houses, raised on posts or piles and common to many families, to prevail from one end of New Guinea to the other, both on the coast and inland, we are led to conclude that those described by Dr. Miklucho Maclay at Astrolabe Bay, on the northeast coast, are exceptional, and indicate the presence of some foreign element. The houses of the people among whom he lived were not raised on posts, and had very low walls, so that the somewhat arched roofs appeared to rise at once from the ground. They were of small dimensions, and seem to correspond pretty closely to those of the Admiralty Islands, New Britain, and New Ireland; so that this part of the coast of New Guinea has probably been colonized from some of the adjacent islands, a view supported by the fact that these people do not use bows and arrows, so general among all the true Papuans, and by other peculiari-

ties. It is somewhat unfortunate that the only scientific man who has resided alone among these people for more than a year, for the express purpose of studying them exhaustively, should have hit upon a place where the natives are probably not true indigenes but an intruding colony, although perhaps long settled in the country. Dr. Miklucho Maclay will no doubt be quoted as the greatest living authority on the Papuans of New Guinea; and it is therefore very important to call attention to the fact that the people he so carefully studied are not typical of the race, and may not even be Papuans at all in the restricted sense in which it is usually applied to the main body of the aborigines of New Guinea.

The Papuans, as well as all the tribes of dark, frizzly-haired Melanesians, make pottery for cooking, thus differing from all the brown Polynesian tribes of the Pacific, none of whom are acquainted with this art. Of course the actual seat of manufacture will be dependent on the presence of suitable materials; but those who do not make it themselves obtain it by barter, so that earthenware cooking-vessels appear to be in general use all over the island. Cups and spoons are made out of shells or cocoanuts, while wooden bowls of various sizes, wooden mortars for husking maize or rice, wooden stools used as pillows, and many other articles, are cut out and ornamented with great skill. A variety of boxes are made of the split leaf-stalks of the sago palm, pegged together and covered with pandanus-leaves, often neatly plaited and stained of different colors, so as to form elegant patterns. A variety of mats, bags, and cordage, are made with the usual skill of savage people; and their canoes are often of large size and beautifully constructed, with high-peaked ends ornamented with carvings, and adorned with plumes of feathers.

The weapons chiefly used are spears of various kinds, wooden swords and clubs, and bows and arrows; the latter being almost universal among the true Papuans and most of the allied frizzly-haired races, while the Polynesians seem never to possess it as an indigenous weapon. It is very singular that neither the Australians, the Polynesians, nor the Malays should be acquainted with this weapon, while in all the great continents it is of unknown antiquity, and is still largely used in America, Asia, and Africa. Peschel, indeed, attempts to show that the Polynesians have only ceased to use it on account of the absence of game in their islands; but mammalia are almost equally scarce in the New Hebrides, where it is in constant use even in the smallest islands; while in Australia, where they abound, and where it would be a most useful weapon, it is totally unknown. We must therefore hold that the use of the bow and arrow by the Papuans is an important ethnological feature, distinguishing them from all the peoples by whom they are immediately surrounded, and connecting them, as do their physical peculiarities, with an ancient widespread negroid type.

In their knowledge and practice of agriculture the Papuans show

themselves to be far superior to the Australians, and fully the equals of the Polynesian races. They grow cocoanuts and bread-fruit, and cultivate various kinds of yam, sweet potato, bananas, and sugar-cane. Though possessing, for the most part, only stone axes, they clear the forest to make their plantations, which they carefully fence round to keep out the wild pigs. Looking at these clearings, at their houses, their canoes, their implements, weapons, and ornaments often elaborately carved, we must, as Dr. Maclay remarks, be struck with astonishment at the great patience and skill displayed by these savages. Their chief implement, the axe, consists of a hard gray, green, or white stone, made smooth and sharp by long grinding and polishing. A piece of the stem of a tree which has a branch passing off at an angle, something like the figure 7, is hewed off, and upon the branch, which has been cut off short and shaven at the top, the stone is laid horizontally, and bound fast with split rattans or tough bark. Such an instrument requires to be used with great skill, only to be attained by practice, or the stone will be broken without producing any result. These savages can, however, with a stone axe having a cutting edge only two inches broad, fell a tree-trunk of twenty inches diameter, or carve really fine figures on a post or spear. Each adult man possesses one such axe, but in every village there are usually one or two larger two-handed axes, which are about three inches broad. These are considered exceedingly valuable, and are only used for cutting large trees for canoes or other important work. Fragments of flint and shells are used for finishing carved work and cutting the ornamental patterns on bamboo boxes, as well as for making combs, spoons, arrows, and other small articles. For cutting meat and vegetables a kind of chisel of bone and knives of bamboo are made use of. On the northwest and southwest coasts, where the people have long been in communication with Malay traders, they have iron tools and weapons, and cultivate also maize and a little rice and millet, and have the papaya as an additional fruit and vegetable; and they also grow tobacco, of which they make huge cigars. At Dorey they have learned to work iron, and make swords and choppers as well as iron points to their arrows and spears.

The daily food of these people consists of some of the vegetables already named, of which they have a pretty constant supply, together with fruits, fish, and occasionally the flesh of the wild pig, the cuscus, or of birds caught in snares or shot with arrows. They also eat shell-fish, lizards, and almost every kind of large insect, especially beetles and their larvæ, which are eaten either raw or cooked. Having no salt, they mix sea-water with that in which they cook their food, and this is so highly esteemed that the people of the hills carry away bamboos full of salt-water whenever they visit the coast.

The plantations are usually made at some distance inland for safety, and, after the ground is cleared and fenced by the men, the cultivation is left almost wholly to the women, who go every day to weed and

bring home some of the produce for the evening's meal. They have throughout the year a succession of fruits and vegetables either wild or cultivated, and are thus never half-starved like the Australians. On the whole the women are well treated and have much liberty, though they are considered as inferiors, and do not take their meals with the men. The children are well attended to, and the fathers seem very fond of their boys, and often take them when very young on their fishing or hunting excursions.

As in the case of most other savages, we have very different and conflicting accounts of the character of the Papuans. Mr. Windsor Earl well remarks, that whenever civilized man is brought into *friendly* communication with savages, the disgust which naturally arises from the first glance at a state of society so obnoxious to his sense of propriety, disappears before a closer acquaintance, and he learns to regard their little delinquencies as he would those of children; while their kindliness of disposition and natural good qualities begin to be recognized. Thus many writers make highly favorable statements respecting the Papuan character and disposition; while those whose communications with them have been of a *hostile* nature are so impressed with their savage cunning and ferocity, and the wild-beast-like nature of their attacks, that they will not recognize in them any feelings in common with more civilized races.

Many of the early voyagers record nothing but hostility or treacherous murders on the part of the Papuans. Their visits were, however, chiefly on the northwest and southwest coasts, which the Malays have long been accustomed to visit not only for commerce but to capture slaves. This having become a regular trade, some of the more warlike coast tribes, especially those of Onin in McCluer's Inlet, have been accustomed to attack the villages of other tribes, and to capture their inhabitants, in order to sell the women and children to the Malays. It is not therefore surprising that unknown armed visitors to these coasts should be treated as enemies to be resisted and if possible exterminated. Even Europeans have sometimes increased this feeling of enmity through ignorance of native habits and customs. Cocoanut-trees have been cut down to obtain the fruit, apparently under the impression that they grew wild and were so abundant as to be of little value; whereas every tree is considered as private property, as they supply an important article of food, and are even more valued than the choicest fruit-trees among ourselves. Thus Schouten, in 1616, sent a boat well armed to bring cocoanuts from a grove of trees near the shore, but the natives attacked the Europeans, wounded sixteen of them, and forced them to retire. Commodore Roggewen, in 1722, cut down cocoanut-trees on the island of Moa on the north coast, which, of course, brought on an attack. At other times houses have been entered in the absence of their owners, a great offense in the eyes of all savage people, and at once stamping the intruder as an enemy.

On the other hand, Lieutenant Bruijn Kops, who visited the northwest coast of New Guinea in 1850, gives the following account of the inhabitants of Dorey:

Their manners and customs are much less barbarous than might be expected. On the contrary, they give evidence of a mild disposition, of an inclination to right and justice, and strong moral principles. Theft is considered by them as a grave offense, and is of very rare occurrence. They have no fastenings to their houses, yet seldom or never is anything stolen. Although they were on board our ship or alongside during whole days, we never missed anything. Yet they are distrustful of strangers until they become acquainted with them, as we experienced. This is probably less, however, a trait of their character than the result of intercourse with strangers who perhaps had frequently tried to cheat them. The men, it is true, came on board from the time of our arrival, but they were very cautious in letting any of the things they brought for sale out of their hands. The women were at first very fearful, and fled on all sides when they saw us, leaving behind what they might be carrying; but at length when they found they had no injury to dread from us they became more familiar. Finally, they approached without being invited, but remained timid. The children very soon became accustomed to us, and followed us everywhere.

Respect for the aged, love for their children, and fidelity to their wives, are traits which reflect honor on their disposition. Chastity is held in high regard, and is a virtue that is seldom transgressed by them. A man can only have one wife, and is bound to her for life. Concubinage is not permitted. Adultery is unknown among them. They are generally very fond of strong drink, but, although they go to excess in this, I could not learn that they prepared any fermented liquor, not even *sago-weer* or *tuak* (palm-wine). Kidnapping is general in these countries, and is followed as a branch of trade, so that there is no dishonor attached to it. The captives are treated well, are exchanged if there are any of theirs in the enemy's hands, or released on payment of a ransom, as was the case in Europe in the middle ages.

My own experience of the Papuans at Dorey, in 1858, agrees with this account; and as I lived there for four months with only four Malay servants, going daily unarmed into the forest to collect insects, I was completely in their power had they wished to attack me. A remarkable proof of their honesty occurred to me at the island of Waigiou, where a man who had received payment in advance for red birds of paradise brought back the money, represented by an axe, when after trying for several weeks he had failed to catch any. Another, who had received payment for six birds, brought me in the fifth two days before I was to leave the island, and immediately started off for the forest to seek another. Of course I never expected to see him again, but, when my boat was loaded, and we were just on the point of starting, he came running down to the beach holding up a bird, which he handed to me, saying with evident satisfaction, "Now I owe you nothing." My assistant, Mr. Allen, venturing along among the mountaineers of the northwest peninsula, found them peaceable and good-natured. Drs. Meyer and Beccari and Signor d'Albertis, penetrating inland beyond Dorey, were never attacked or seriously opposed; and Dr. Miklucho

Maclay suddenly appearing at Astrolabe Bay, among people who seem never to have had any communication with Europeans, soon established friendly relations with them, although subject to great trials of temper and courage at the outset.

His experience with them is very instructive. They appeared at first distrustful and suspicious of his intentions, as well they might be. Sometimes they left him quite alone for days together, or kept him prisoner in the little hut he had had built for himself, or tried to frighten him by shooting arrows close to his head and neck, and pressing their spears against his teeth till they made him open his mouth. Finding, however, that he bore all these annoyances good-humoredly, and, as a medical man, took every opportunity of doing them services, they concluded he was a good spirit, a man from the moon, and thenceforth paid him great respect, and allowed him to go about pretty much as he pleased. This reminds us of the experience of the Challenger at Humboldt Bay, where it was decided not to stay, because some of the natives similarly drew their bows at the officers when away in boats. This was no doubt nervous work for the person threatened, but it was only a threat. Savages do not commence a real attack in that theatrical way, and, if they had been met with coolness and their threats been laughed at or treated with contempt, such demonstrations would soon have ceased. Of course it requires very exceptional courage and temper, not possessed by one man in a thousand, to do this; but the fact should be remembered that in many parts of the world such attempts to frighten Europeans have been adopted, but have never resulted in anything serious. Had the Papuans really wanted to rob and murder, they would have enticed the Challenger people on shore, where they would have had them completely at their mercy, whereas those who did go on shore were very civilly treated.

One of the most curious features noticed by Dr. Miklucho Maclay was the apparent absence of trade or barter among the people of Astrolabe Bay. They exchange presents, however, when different tribes visit each other, somewhat as among the New-Zealanders, each party giving the other what they have to spare; but no one article seems ever to be exchanged for another of supposed equivalent value. On the whole, the Russian doctor seems to have found these people industrious, good-natured, and tolerably cleanly, living orderly lives, and conforming themselves strictly to the laws and customs which to them determine what is right.

Captain Moresby, Signor d'Albertis, Mr. O. C. Stone, and the missionaries who have recently explored the southeastern extremity of New Guinea, have been greatly struck by the apparently quite distinct races they have found there. As far eastward as the head of the gulf of Papua (on the east side of Torres Straits) the typical Papuans prevail, the natives of the Katow River being described as nearly black,

with Jewish noses, and woolly hair, using bows and arrows, and living in houses a hundred feet long elevated on posts, in all respects exactly agreeing with the prevalent type in the western portion of the island. But farther east, about Redscar Bay and Port Moresby, and thence to East Cape, the people are lighter in color, less warlike, and more intelligent, with more regular European features, neither making bows nor (except rarely) pottery, and practicing true tattooing by punctures—all distinctly Polynesian characteristics. When to this we add that their language contains a large Polynesian element, it is not surprising that these people have been described as a totally distinct race, and have been termed Malays or Malayo-Polynesians. We fortunately possess several independent accounts of these tribes, and are thus able to form a tolerably good idea of their true characters.

Captain Moresby, speaking of the inhabitants of that large portion of the eastern peninsula of New Guinea discovered and surveyed by him, says:

> This race is distinctly Malayan; but differs from the pure Malay, being *smaller in stature*, coarser in feature, *thicker-lipped*, with *less hair on the face*, being in fact almost beardless. The hair on the head is also *more frizzled*, though this may result from a different dressing. These men have high cheekbones like the pure Malay; their noses are inclined to be aquiline and sometimes very well formed. Among them are met many men with light hair, and what struck us as a peculiarly *Jewish cast of features*. They rise to a height of from five feet four inches to five feet eight inches, are sinewy though not muscular, *slight, graceful, and cat-like* in the pliability of their bodies.*

This description clearly shows that by "Malay" Captain Moresby means "Polynesian," the characters mentioned being in almost every respect directly the opposite of those of the true Malays, as indicated by the words and phrases here placed in italics. And, even as compared with the typical brown Polynesians, the frizzled hair, aquiline noses, and Jewish cast of features, are all Papuan characteristics.

Mr. Octavius C. Stone describes the Motu tribe who inhabit the coast districts about Redscar Bay and Port Moresby as somewhat shorter than the Papuans to the westward, and of a color varying from light brown to chocolate. The hair varies from nearly straight to woolly, often being frizzled out like that of the typical Papuan. The hair on the face is artificially eradicated, and they are thus made to appear beardless. The nose is aquiline and thick, and in a small percentage of the men the Jewish type of features appears. The adjacent tribes differ somewhat. The Koiari, Ilema, and Maiva are generally darker in color; while the Kirapuno are lighter. These last live near Hood Point, and are the handsomest people in New Guinea. Their hair is of a rich auburn, often golden in the children, growing in curls or ringlets. It is this tribe that keep their villages in such excellent order, with

* "Journal of the Royal Geographical Society," vol. xlv., p. 163.

well-kept gardens in which they even cultivate flowers. Mr. Lawes says: "We were all amazed at the cleanliness, order, and industry, which everywhere declared themselves in this model New Guinea village. The men are physically very fine and the women good-looking. One of the belles of the place had no less than fifty-four tortoise-shell ear-rings in her two ears, and her nose pierced too."*

Speaking of all these tribes as forming essentially one race, Mr. Stone says that they are a merry, laughter-loving people, fond of talking, and loving a joke, hot of temper, and quick to resent a supposed injury —all of which are Polynesian or Papuan as opposed to Malayan characteristics. They are clean in their habits, and particularly so in their eating. When allowed liberties they do not fail to take advantage; and, at Port Moresby in particular, they are accomplished thieves, inveterate liars, confirmed beggars, and ungenerous to a degree, so that, even if starving, they would give you nothing without an equivalent. This condemnation, however, does not apply to the interior tribes who have not yet been demoralized by European visitors. Both sexes are vain of their outward appearance, oiling their bodies, and adorning themselves with shells, feather and bone ornaments; and on all festive occasions each tries to outvie the other in his or her toilet. Their dress is like that of the Papuans, a T-bandage for the men, a fringe of leaves for the women, but the latter are more carefully made than among the more savage tribes. They practice true tattooing, the women especially being often highly ornamented with complex patterns on the body and limbs, and occasionally on the face also, but wanting the elegant curves and graceful designs which characterize Polynesian tattooing.† Their weapons are spears, shields, stone clubs, and hatchets, one tribe only—the Ilema—making bows and arrows. In like manner the Motu tribe only make pottery, which the other tribes obtain from them by barter. They use drilling-machines with a spindle-wheel and cord, like the Polynesians. The houses, whether on the shore or inland, are raised on piles, but are small as compared with those of the Papuans, each accommodating one or two families only.

Intellectually these people are considerably advanced. They can reckon up to a million. They use the outstretched arms as a unit to measure by. They divide the year into thirteen months, duly named, and reckoned from the new moons. The four winds and many of the stars have names, as well as every tree, shrub, flower, and even each well-marked grass and fern. They prefer fair to dark people, and are thus disposed to like and admire the white races. The children are very merry, and have many toys and games. The Rev. W. Turner tells us that they make small windmills of cocoanut-leaves, and are well versed in the mysteries of cat's-cradle; while spinning a button

* Journal kept by Mr. Lawes, "Times," November 27, 1876.

† See figures illustrating the Rev. W. Turner's article on "The Ethnology of the Motu," in the "Journal of the Anthropological Institute," 1878, p. 480.

or round piece of shell on a cord, and keeping a bladder in the air by patting it with the hands, are favorite games. They also amuse themselves with miniature spears and bow and arrows, catching fish, which they cook for themselves on the shore. They are left to do what they like, and know nothing of the tasks of school, the troubles of keeping their clothes clean, or the miseries of being washed—troubles that vex the lives of almost all civilized children. According to Mr. Turner, the villages of the Motu are by no means clean, all manner of filth being left about unheeded; and, as this agrees with most other descriptions, we must conclude that the model village already referred to is quite exceptional in its cleanliness and order.

Mr. Turner thinks the Motu are colonists from some other land, while he considers the Koiari of the interior to be "evidently the aborigines of this part of New Guinea." Mr. Stone, on the other hand, classes them together as slightly differing tribes of the same race, the one being a little more advanced than the other; and he considers the whole eastern peninsula of New Guinea to be peopled by a race of Polynesian blood, who, in some far-distant time, found their way to the coast, intermingled with the native Papuan tribes, and gradully drove them westward. There have thus resulted a number of separate tribes, showing various degrees of intermixture, the Polynesian blood predominating on the coast, the Papuan in the interior; one small tribe alone, the Kirapuno, being more distinctly Polynesian. How complete is the intermixture, and how difficult it is to determine the limits of the two races, are shown by the opinion of Mr. S. McFarlane, who says that though he at first thought the people of Katow River and those of Redscar Bay to be quite distinct, the former Papuan and the latter Malayan (or more properly Polynesian), yet, after five years' acquaintance with them, he believes them to of the same race; while he considers the tribes of the interior to be distinct, and to be true Papuans. The coast people he thinks to be the result of an intermixture of Malays, Polynesians, Arabs, Chinese, and Papuans.

Dr. Comrie (of the surveying ship Basilisk) believes that all the tribes on the northeast coast, from East Cape to Astrolabe Bay, are Papuans; but his description of them shows that they have a slight infusion of Polynesian blood, and many Polynesian customs. One thing is very clear, that neither in physical nor mental characteristics do these people show any resemblance whatever to Malays, who are a very different race from the Polynesian. The graceful figures, the woolly or curly hair, the arched noses, the use of tattooing, the ignorance of pottery-making, the gay and laughter-loving disposition, the talkativeness of the women, the lying, thievishness, and beggary, widely separate them from the Malay; while all these peculiarities support the view of their being a race formed by a mixture of Polynesian men with Papuan or Melanesian women, the former having perhaps arrived in successive waves of immigration, thus causing the coast tribes, and those nearest the east-

ern end of the island, to be more distinctly Polynesian in character than those inland and toward the west.

Returning now to the dark Papuan tribes of the remainder of New Guinea, we find that here also there is some difference of opinion. Owing to the coast tribes being usually at war with those of the interior, these latter have been described by them as a different race, and have been called by the Dutch and other writers Alfuros * or Harafuras, a term applied to any wild people living in the interior of a country, as opposed to the coast tribes. This has led many writers to class the natives of New Guinea into Papuans and Harafuras, terms which are still sometimes used, but which are quite erroneous as implying any physical difference or any distinction of race. Dr. Meyer, who has seen much of the people of the northwest coast, considers that there is no difference of the slightest importance between the coast and inland tribes, but such as occur in every race. Dr. Miklucho Maclay concludes that the Papuan stock consists of numerous varieties, with no sharp lines of demarkation. Dr. Beccari, however, differs somewhat from the preceding writers; and as he explored a great range of country, and made repeated visits to the western half of New Guinea, his opinion is entitled to great weight. He thinks there are three distinct types of Papuans. One is dwarfish, with short woolly hair, skin almost or quite black, nose much depressed, forehead extremely narrow and slanting, and with a brachycephalous cranium; these he terms Oriental negroes or Primitive Papuans. They do not now exist as a race, but are scattered among the interior tribes, and their description accords very closely with that of the Negritos of the Philippines and the Semangs of the Malay Peninsula. The next are the Typical Papuans, who are most widely spread, and present most of the characteristic features we have already described. The last are the Mafu or Mafor Papuans who inhabit Dorey and the shores and islands of Geelvink Bay, and are probably scattered all round the western coasts. They form the highest type, with fine Jewish or European features, a better intellect, and a somewhat more advanced civilization. These people divide the year into lunar months, each with a proper name, and have names for the four cardinal points, for many stars, and for entire constellations. Dr. Beccari believes them to be the result of an intermixture (at a remote epoch) of Hindoo or Caucasian blood with the indigenes of the island, and he even traces a connection between their rude mythology and that of the Hindoos.

A curious point of physiological detail may here be noticed as lending some support to this theory. Almost all observers have remarked that the fully developed Papuan mop of hair is not a general feature in any of the tribes, but occurs sporadically over a wide area, is highly

* The term is derived from the Portuguese "fora," out or outside; Alfores being applied to tribes out of or beyond the settlement on the coast (Windsor Earl's "Papuans," p. 62).

valued by its possessors, and from its extreme conspicuousness is always noticed by travelers. No other *race* of people in the world possesses this character at all; but, strange to say, it appears very fully developed among the Cafusos of Brazil. These are a mixed race, the produce of negro and Indian parents, and their enormous wigs of frizzly hair have been described by Spix and Martius, and are known to most South American travelers. Still more interesting is the appearance of a similar peculiarity among the Arab tribes of Taku in eastern Africa, where mixtures of negro and Arab blood are very common.* It is well known that hybrid and mongrel characters are liable to great variation, and are very uncertain in their appearance or degree of development. If, therefore, the higher type of Papuans are the result of a remote intermixture of Hindoos or Arabs with the indigenous Papuans, we can account both for the appearance of the great mop of frizzly hair and for its extremely unequal development; and it is not improbable that the Jewish and greatly elongated nose may have a similar origin.

If we now take account of all the evidence yet obtained, we seem justified in concluding that the great mass of the inhabitants of New Guinea form one well-marked race—the Papuan—varying within comparatively narrow limits, and everywhere presenting distinctive features which separate it from all other races of mankind. The only important deviation from the type occurs in the southeastern peninsula, where a considerable Polynesian immigration has undoubtedly taken place, and greatly modified the character of the population. At other points immigrants from some of the surrounding islands may have formed small settlements, but it is a mistake to suppose that there are any Malay colonies on the southwest coast, though some of the natives may have adopted the Malay dress and some of the outward forms of Mohammedanism.

If we look over the globe for the nearest allies of the Papuans, we find them undoubtedly in equatorial and southern Africa, where alone there is an extensive and varied race of dark-colored, frizzly-haired people. The connecting links are found in the dwarfish, woolly-haired tribes of the Philippines, the Malay Peninsula, and the Andaman Islands; and, taking these altogether, we may well suppose them to represent one of the earliest, if not actually the most primitive type of man. It is customary to consider the Australians to be a lower race, and they undoubtedly are so intellectually, but this by no means proves that they are more primitive. The Australian's hair is fine and glossy like our own; and no one can look at a good series of photographs of natives without being struck with the wonderful resemblance many of them bear to countenances familiar to us at home—coarse and brutalized indeed, but still unmistakably similar.

We must also take note of the fact that the two great woolly-haired

* Waitz's "Anthropology," English translation, vol. i., p. 175.

races are almost entirely confined within the tropics, and both attain their highest development near the equator. It is here that we should expect the primitive man to have appeared, and here we still find what may well be his direct descendants thriving best. We may, perhaps, even look on the diverse types of the other great races as in part due to changes of constitution adapting them to cooler climates and changed conditions; first, the Australians and the hill tribes of central India, who once perhaps spread far over the northern hemisphere, but have been displaced by the Mongoloid type, which flourishes at this day from the equator to the pole. These, again, have been ousted from some of the fairest regions of the temperate zone by the Indo-Europeans, who seem only to have attained their full development and highest vigor when exposed to the cold winds and variable climate of the temperate regions.

If this view is correct, and the Papuans really form one branch of the most primitive type of man which still exists on the globe, we shall continue to look upon them with ever-increasing interest, and shall welcome every fact relating to them as important additions to the history of our race. The further exploration of their beautiful and luxuriant island will, it is to be hoped, be vigorously pursued, not only to obtain the mineral, vegetable, and animal treasures that still lie hid in its great mountain ranges, but also to search for the remains of primeval man in caves or alluvial deposits, and thus throw light on the many interesting problems suggested by the physical peculiarities and insular position of the Papuan race.—*Contemporary Review.*

DANGERS OF DARWINISM.*

MR. DARWIN has certainly achieved the distinction of being recognized as the "bogey" of his generation. What Bonaparte was to the English tradesman and his family at the beginning of this century, the great evolutionist is at present to pious Clapham and chapel-going Holloway. Vast numbers of virtuous vestrymen frighten the old women of their parishes with the mere mention of his name. Sentiments and sayings are put into his mouth which would come equally well from that of the enemy of mankind. His conspiracy against the peace of the British matron is so diabolical that even bishops sometimes thunder at him, and good people of an old-fashioned way of thinking have a conviction that he ought, in this world or another, to be burned. It is no use for tender-hearted clergymen, in the great reviews and elsewhere, to recommend him to mercy, and to suggest that his theories after all may not be altogether so infamous as

* "The Darwinian Theory Examined." London: Bickers & Sons.

the lovers of damnation would insinuate. It is no use for him, himself, to mildly plead that he is no iconoclast, and makes no pretense whatever to have fathomed the solemn mysteries of Nature. His great offense has been committed, and he is condemned out of the mouth of his enemies to moral excommunication. Curiously enough, those most indignant at the suggestion of an ape-like ancestry are the individuals who are pretty generally admitted to be descendants of quite another species. By these the dangers of Darwinism are proclaimed with unwearied iteration, and thus the bray of the donkey confutes the folly which affirms man to be an offshoot of some archetypal baboon.

The author of this "Darwinian Theory Examined" is anonymous, but from the anxiety he shows to be "written down" *not* an ape, we have no hesitation in saying that he belongs to the Dogberry family of dissenters from the faith of modern science. Under what temptation he first thought of coming forward as the critic of Darwinism, and of speaking so loudly on behalf of the claims of his own ancestry, we are at a loss to guess; but we may at once say that he has made us fully alive to the limitations of the great modern theory of man's descent. A theory which relegates all men to the great monkey family, and makes no account of those who confidently establish and vindicate a descent from the four-footed companion of Balaam, must be defective somewhere, as our anonymous author shows. With a charming coherence, he compares Darwinism to phrenology, and again to mesmerism, and again to what he calls phrenomesmerism. "None of these," he says, "could have sprung from nothing (*sic*) that was reasonable; they all held on by the skirts of truth, and they have all had their hour of triumph"; and he continues, "Every one of a certain age may remember how phrenology flourished, how people hired servants, selected associates, and so forth, by its rules." We ourselves are of a certain age, but we really don't remember so much; and the period when people "hired servants" and "selected associates" by feeling their bumps must have been previous to our editorial infancy. There is now a danger, we presume, that people may do such things by the rules of Darwinism, but the author fails to inform us whether we are likely to "select" servants and intimate friends because they do, or because they do not, present in their faces and on their persons indications of their apely origin? As to the common results of the theory, however, he is far more explicit, and the case that he reports is so awful that we hope all our readers will take warning. "A man," he says, "was lately reported in America as giving a lecture, at the close of which he had advertised his intention to destroy himself. The audience was considerable. . . . Having concluded a most interesting discourse, he, in compliance with his advertised intention, before any one could interfere, drew a pistol out of his pocket and blew his brains out. *At his lodging was found a will, leaving all his property to purchase the works of Darwin, Tyndall, and Huxley for the public library of the district.*"

After that, can any rational being doubt that Mr. Darwin has much to answer for? "Such," the author triumphantly cries, "being some of the Darwinian theory's proved results (!), its suppression on the ground of being contrary to Nature and her true interpretation is clearly an object much to be desired"!!

When our author descends from generalities and comes to tackle Mr. Darwin on his own ground, his intellectual feats are simply marvelous. In answer to the philosopher's question whether differences of bodily structure and mental faculties are transmitted to offspring, he replies that the "answer is in the negative, because we every day see tall fathers with short sons, and the reverse—wise men and thrifty, with fools and spendthrifts for children!" Nevertheless, he naively confesses a little further on that "hereditary peculiarities certainly exist." His reflections are both profound and elevating: "Facially there are men and women who bear strong resemblance to owls, baboons, and other of the lower order of animals. In fact, an illustrated book has been published concerning these peculiarities; but these are not to the point, and prove nothing." Then why adduce them? a poor heathen might demand; but really we can not follow our author through the phases of his deep and dangerous argument. He gives it to Mr. Darwin tremendously, and is very high and haughty with him whenever he catches him prevaricating. Sometimes, indeed, he is barely civil: "This argument is of the *lucus a non lucendo* order, and the premises are as false as the conclusion." When the poor philosopher mildly dissents, he is ready to disconcert him altogether with an aside to the reader: "And here I may remark that the French Academy deliberately and wisely refused him (Mr. Darwin) admission into their body (three times, I have heard), for the reason that his views of Nature were not legitimately founded on facts or science." He adds loftily, in the finest manner of Mr. Podsnap: "Of this I have not personal knowledge; I have only been told so."

Here and there he is almost too hard on Mr. Darwin, as when he says: "His approach to the deep mysteries of Nature is in the *veni, vidi, vici* style, little affected by the fact that he has no power of himself to make the lowest living form of being." Really, Mr. Darwin makes no pretense to any powers of creation, unless it be in a modest literary way. Again, our critic says that, on a review of the whole "Descent of Man," this strikes him: "That any one, who can discover legitimate proof of the origin of man in its assumption, may truly be said to see with the eyes of Darwin, and not with those of God." Really, all an ordinary man can do is to see with his own eyes, if he possesses any, and not even a critic of superhuman stupidity could do much more. We regret to see these blemishes on so characteristic a book, for we are sure that it is one that will be welcomed by many a frightened matron, and by not a few seraphic spinsters. Such a work was wanted, not only to exhibit the dangers of Darwinism in its pos-

sible effects on the inmates of Hanwell, but to concentrate in one concise and complete *vade mecum* all the irrelevant twaddle of the ancient house of Dogberry. If Mr. Darwin survives this attack, he will at least know that the force of utter flabbiness can go no further. To the present generation he is a very Goliath of the Philistines; but, though the cranium of a catarrhine-ape may some day confute him, he is not to be annihilated in this off-hand fashion by the jawbone of an ass.—*Examiner.*

DISEASE OF THE BODY AS A MENTAL STIMULANT.

DURING special states of disease the mind sometimes develops faculties such as it does not possess when the body is in full health. Some of the abnormal qualities thus exhibited by the mind seem strikingly suggestive of the possible acquisition by the human race of similar powers under ordinary conditions. For this reason, though we fear there is no likelihood at present of any practical application of the knowledge we may obtain on this subject, it seems to us that there is considerable interest in examining the evidence afforded by the strange powers which the mind occasionally shows during diseases of the body, and especially during such diseases as are said, in unscientific but expressive language, to lower the tone of the nervous system.

We may begin by citing a case which seems exceedingly significant. Miss H. Martineau relates that a congenital idiot, who had lost his mother when he was less than two years old, when dying, "suddenly turned his head, looked bright and sensible, and exclaimed, in a tone never heard from him before, 'O my mother! how beautiful!' and sank down again—dead." Dr. Carpenter cites this as a case of abnormal memory, illustrating his thesis that the basis of recollection "may be laid at a very early period of life." But the story seems to contain a deeper meaning. The poor idiot not only recalled a long-past time, a face that he had not seen for years except in dreams, but he gained for a moment a degree of intelligence which he had not possessed when in health. The quality of his brain was such, it appears, that with the ordinary activity of the circulation, the ordinary vitality of the organ, mental action was uncertain and feeble; but when the circulation had all but ceased, when the nervous powers were all but prostrate, the feeble brain, though it may have become no stronger actually, became relatively stronger, in such sort that for the time being, a mere moment before dissolution, the idiot became an intelligent being.

A somewhat similar case is on record in which an insane person, during that stage of typhus fever in which sane persons are apt to become delirious, became perfectly sane and reasonable, his insanity re-

turning with returning health. Persons of strongest mind in health are often delirious for a short time before death. Since, then, the idiot in the same stage of approaching dissolution may become intelligent, while the insane may become sane under the conditions which make the sane become delirious, we recognize a relationship between the mental and bodily states which might be of considerable use in the treatment of mental diseases. It may well be that conditions of the nervous system which are to be avoided by persons of normal mental qualities may be advantageously superinduced in the case of those of abnormally weak or abnormally violent mind. It is noteworthy that different conditions would seem to be necessary for the idiotic and for the insane, if the cases cited sufficed to afford basis for generalization. For the idiot of Miss Martineau's story became intelligent during the intense depression of the bodily powers immediately preceding dissolution, whereas the insane person became sane during that height of fever when delirium commonly makes its appearance.

Sir H. Holland mentions a case which shows how great bodily depression may affect a person of ordinarily clear and powerful mind. "I descended on one and the same day," he says, "two very deep mines in the Hartz Mountains, remaining some hours underground in each. While in the second mine, and exhausted both from fatigue and inanition, I felt the utter impossibility of talking longer with the German inspector who accompanied me. Every German word and phrase deserted my recollection; and it was not until I had taken food and wine, and been some time at rest, that I regained them again."

A change in the mental condition is sometimes a sign of approaching serious illness, and is felt to be so by the person experiencing it. An American writer, Mr. Butterworth, quotes the following description given by a near relative of his who was suffering from extreme nervous debility: "I am in constant fear of insanity," she said, "and I wish I could be moved to some retreat for the insane. I understand my condition perfectly; my reason does not seem to be impaired; but I can think of *two things at the same time.* This is an indication of mental unsoundness, and is a terror to me. I do not seem to have slept at all for the last six months. If I sleep, it must be in a succession of vivid dreams that destroy all impression of somnolence. Since I have been in this condition, I seem to have a very vivid impression of what happens to my children who are away from home, and I am often startled to hear that these impressions are correct. I seem to have also a certain power of anticipating what one is about to say, and to read the motives of others. I take no pleasure in this strange increase of mental power; it is all unnatural. I can not live in this state long, and I often wish I were dead."

It must, however, be remembered that persons who are in a state of extreme nervous debility not only possess at times abnormal mental qualities, but are also affected morally. As Huxley has well remarked

of some stories bearing on spiritualism, they come from persons who can hardly be trusted even according to their own account of themselves. Mr. Butterworth's relation described a mental condition which, even if quite correctly pictured as she understood it, may yet be explained without believing that any very marvelous increase had taken place in her mental powers. Among the vivid impressions which she constantly had of what might be happening to her children away from home, it would have been strange if some had not been correct. The power of anticipating what others were about to say is one which many imagine they have, mistaking the occasional coincidence between their guesses and what has been next said for indications of a power which in reality they do not possess. And so also with regard to the motives of others. Many are apt, especially when out of health, to guess at others' motives, sometimes rightly, but oftener very wrongly, yet always rightly in their own belief, no matter what evidence may presently appear to the contrary.

The case cited by Mr. Butterworth affords evidence rather of the unhealthy condition of the patient's mind than of abnormal powers, except as regards the power of thinking of two things at the same time, which we may fairly assume was not ordinarily possessed by his relatives. It is rather difficult to define such a power, however. Several persons have apparently possessed the power, showing it by doing two things at the same time which both appear to require thought, and even close attention. Julius Cæsar, for example, could write on one subject and dictate on another simultaneously. But, in reality, even in cases such as these, the mind does not think of two things at once. It simply takes them in turn, doing enough with each, in a short time, a mere instant, perhaps, to give work to the pen or to the voice, as the case may be, for a longer time. When Cæsar was writing a sentence, he was not necessarily thinking of what he was writing. He had done the thinking part of the work before; and was free, while continuing the mere mechanical process of writing, to think of matter for dictation to his secretary. So also while he was speaking, he was free to think of matter for writing. If, indeed, the thought for each sentence of either kind had occupied an appreciable time, there would have been interruptions of his writing, if not of his dictation (dictation is not commonly a continuous process under any circumstances, even when shorthand writers take down the words). But a practiced writer or speaker can in a moment form a sentence which shall occupy a minute in writing and several seconds in speaking.

The present writer, who certainly does not claim the power of thinking of two things at once (nay, believes that no one ever had or could have such a power), finds it perfectly easy, when lecturing, to arrange the plan for the next ten minutes' exposition of a scientific subject, and to adopt the words themselves for the next twenty seconds or so, while continuing to speak without the least interruption. He has also worked

out a calculation on the blackboard, while continuing to speak of matters outside the subject of the calculation. It is more a matter of habit than an indication of any mental power, natural or acquired, to speak or write sentences, even of considerable length, after the mind has passed on to other matters. In a similar way some persons can write different words with the right and left hands, and this, too, while speaking of other matters. (We have seen this done by Professor Morse, the American naturalist, whose two hands added words to the diagrams he had drawn while his voice dealt with other parts of the drawing; to add to the wonder, too, he wrote the words indifferently from right to left or from left to right.) In reality the person who thus does two things at once is no more thinking of two things at once than a clock is, when the striking and the working machinery are both in action at the same time.*

As an illustration of special mental power shown in health, by a person whose mental condition in illness we shall consider afterward, Sir Walter Scott may be mentioned. The account given by his amanuensis has seemed surprising to many, unfamiliar with the nature of literary composition (at least after long practice), but is in reality such as any one who writes much can quite readily understand, or might even have known must necessarily be correct. "His thoughts," says the secretary to whom Scott dictated his "Life of Napoleon Bonaparte,"

* Since the above was written we have noticed a passage in Dr. Carpenter's "Mental Physiology," p. 719, bearing on the matter we have been dealing with: "The following statement recently made to the writer by a gentleman of high intelligence, the editor of a most important provincial newspaper, would be almost incredible, if cases somewhat similar were not already familiar to us: 'I was formerly,' he said, 'a reporter in the House of Commons; and it several times happened to me that, having fallen asleep from sheer fatigue toward the end of a debate, I had found, on awaking after a short interval of entire unconsciousness, that I had continued to note down correctly the speaker's words. I believe,' he added, 'that this is not an uncommon experience among Parliamentary reporters.' The reading aloud with correct emphasis and intonation, or the performance of a piece of music, or (as in the case of Albert Smith) the recitation of a frequently repeated composition, while the conscious mind is *entirely engrossed* in its own thoughts and feelings, may be thus accounted for without the supposition that the mind is actively engaged in two different operations at the same moment, which would seem tantamount to saying that there are two egos in the same organism." An instance in the writer's experience seems even more remarkable than the reporter's work during sleep, for he had but to continue a mechanical process, whereas in the writer's case there must have been thought. Late one evening at Cambridge the writer began a game of chess with a fellow student (now a clergyman, and well known in chess circles). The writer was tired after a long day's rowing, but continued the game to the best of his ability until at a certain stage he fell asleep, or rather fell into a waking dream. At any rate, all remembrance of what passed after that part of the game had entirely escaped him when he awoke or returned to consciousness about three in the morning. The chess-board was there, but the men were not as when the last conscious move was made. The opponent's king was checkmated. The writer supposed his opponent had set the men in this position either as a joke or in trying over some end game. But he was assured that the game had continued to the end, and that he (the writer) had won, apparently playing as if fully conscious! Of course, he can not certify this of his own knowledge.

"flowed easily and felicitously, without any difficulty to lay hold of them or to find appropriate language" (which, by the way, is more than all would say who had read Scott's "Life of Bonaparte," and certainly more than can be said of his secretary, unless it really was a familiar experience with him to be unable to lay hold of his thoughts). "This was evident by the absence of all solicitude (*miseria cogitandi*) from his countenance. He sat in his chair, from which he rose now and then, took a volume from the bookcase, consulted it, and restored it to the shelf—all without intermission in the current of ideas, which continued to be delivered with no less readiness than if his mind had been wholly occupied with the words he was uttering. It soon became apparent to me, however, that he was carrying on two distinct trains of thought, one of which was already arranged and in the act of being spoken, while at the same time he was in advance, considering what was afterward to be said. This I discovered" (he should rather have said, "this I was led to infer") "by his sometimes introducing a word which was wholly out of place—*entertained* instead of *denied*, for example—but which I presently found to belong to the next sentence, perhaps four or five lines further on, which he had been preparing at the very moment when he gave me the words of the one that preceded it." In the same way the present writer has unconsciously substituted one word for another in lecturing, the word used always belonging to a later sentence than the word intended to be used. We have noticed also this peculiarity, that, when a substitution of this kind has been once made, an effort is required to avoid repeating the mistake, even if it be not repeated quite unconsciously to the end of the discourse. In this way, for example, the writer once throughout an entire lecture used the word "heavens" for the word "screen" (the screen on which lantern pictures were shown). A similar peculiarity may be noticed with written errors. Thus in a treatise on a scientific subject, in which the utmost care had been given to minute points of detail, the present writer once wrote "seconds" for "minutes" throughout several pages —in fact, from the place where first the error was made, to the end of the chapter. (See the *first* edition of Proctor's "Transits of Venus," pp. 131–136, noting as an additional peculiarity that the whole object of the chapter, in which this mistake was made, was to show how many minutes of difference existed between the occurrence of certain events.)

An even more curious instance of a mistake arising from doing one thing while thinking of another occurred to the writer fourteen years ago. He was correcting the proof-sheets of an astronomical treatise in which occurred these words: "Calling the mean distance of the earth 1, Saturn's mean distance is 9·539; again, calling the earth's period 1, Saturn's mean period is 29·457: now, what relation exists between these numbers 9·539 and 29·457 and their powers? The first is less than the second, but the square of the first is plainly greater than the second; we must therefore try higher powers," etc. The passage was

quite correct as it stood, and, if the two processes by which the writer was correcting verbal errors and following the sense of the passage had been really continuous processes of thought, unquestionably the passage would have been left alone. If the passage had been erroneous and had been simply left in that condition, the case would have been one only too familiar to those who have had occasion to correct proofs. But what the writer actually did was deliberately to make nonsense of the passage while improving the balance of the second sentence. He made it run, "The first is less than the second, but the square of the first is plainly greater than the square of the second," the absurdity of which statement a child would detect. If the first proof in its correct form, with the incorrect correction carefully written down in the margin, had not existed, when, several months later, the error was pointed out in the "Quarterly Journal of Science," the writer would have felt sure that he had written the words wrongly at the outset. For blunders such as this are common enough. But, that he should deliberately have taken a correctly worded sentence and altered it into utter absurdity, he could not, but for the evidence, have believed to be possible. The case plainly shows that not only may two things be done at once, when the mind, nevertheless, is thinking only of one, but that something may be done which suggests deliberate reflection, when in reality the mind is elsewhere or not occupied at all. For in this case both the processes on which the writer was engaged were manifestly carried on without thought, one being purely mechanical, and the other, though requiring thought if properly attended to, being so imperfectly effected as to show that no thought was given to it.

To return to Sir Walter Scott. It is known but too well that during the later years of his life there came with bodily prostration a great but not constant failure of his mental powers. Some of the phenomena presented during this part of his career are strikingly illustrative of abnormal mental action occurring even at times when the mental power is on the whole much weakened. "The Bride of Lammermoor," though not one of the best of Scott's novels, is certainly far above such works as "Count Robert of Paris," "The Betrothed," and "Castle Dangerous." Its popularity may perhaps be attributed chiefly to the deep interest of the "ower true tale" on which it is founded; but some of the characters are painted with exceeding skill. Lucy herself is almost a nonentity, and Edgar is little more than a gloomy, unpleasant man, made interesting only by the troubles which fall on him. But Ailsie Gourlay and Caleb Balderstone stand out from the canvas as if alive; they are as lifelike and natural, yet as thoroughly individualized, as Edie Ochiltree and Meg Merrilies. The novel neither suggested when it first appeared, nor has been regarded even after the facts became known, as suggesting that Scott, when he wrote it, was in ill health. Yet it was produced under pressure of severe illness, and when Scott was at least in this sense unconscious, that nothing of what he said and did in connection with

the work was remembered when he recovered. "The book," says James Ballantyne, "was not only written, but published, before Mr. Scott was able to rise from his bed; and he assured me that, when it was first put into his hands in a complete shape, *he did not recollect one single incident, character, or conversation it contained!* He did not desire me to understand, nor did I understand, that his illness had erased from his memory the original incidents of the story, with which he had been acquainted from his boyhood. These remained rooted where they had ever been; or, to speak more explicitly, he remembered the general facts of the existence of the father and mother, of the son and daughter, of the rival lovers, of the compulsory marriage, and the attack made by the bride upon the hapless bridegroom, with the general catastrophe of the whole. *All these things he recollected*, just as he did before he took to his bed; *but he literally recollected nothing else*—not a single character woven by the romancer, not one of the many scenes and points of humor, not *anything with which he was himself connected*, as the writer of the work."

Later, when Scott was breaking down under severe and long-continued labor, and first felt the approach of the illness which ultimately ended in death, he experienced strange mental phenomena. In his diary for February 17, 1829, he notes that on the preceding day, at dinner, though in company witht wo or three old friends, he was haunted by "a sense of preëxistence," a confused idea that nothing that passed was said for the first time; that the same topics had been discussed, and that the same persons had expressed the same opinions before. "There was a vile sense of a want of reality in all that I did or said."

Dr. Reynolds related to Dr. Carpenter a case in which a Dissenting minister, who was in apparently sound health, was rendered apprehensive of brain-disease—though, as it seemed, without occasion—by a lapse of memory similar to that experienced by Sir Walter Scott. He "went through an entire pulpit service on a certain Sunday morning with the most perfect consistency—his choice of hymns and lessons and his *extempore* prayer being all related to the subject of his sermon. On the following Sunday morning he went through the introductory part of the service in precisely the same manner—giving out the same hymns, reading the same lessons, and directing the *extempore* prayer in the same channel. He then gave out the same text and preached the very same sermon as he had done on the previous Sunday. When he came down from the pulpit it was found that he had not the smallest remembrance of having gone through precisely the same service on the previous Sunday; and, when he was assured of it, he felt considerable uneasiness lest his lapse of memory should indicate some impending attack of illness. None such, however, supervened; and no *rationale* can be given of this curious occurrence, the subject of it not being liable to fits of "absence of mind," and not having had his thoughts engrossed at the time by any other special preoccupation." Itis possible that the

explanation here is the simple one of mere coincidence. Whether this explanation is available or not would depend entirely on the question whether the preacher's memory was ordinarily trustworthy or not, whether in fact he would remember the arrangements, prayers, sermon, etc., he had given on any occasion. These matters becoming, after long habit, almost automatic, it might very well happen that the person going through such duties would remember them no longer and no better than one who had been present when they were performed, and who had not paid special attention to them. That if he had thus unconsciously carried out his duties on one Sunday he should (being to this degree forgetful) conduct them in precisely the same way on the next Sunday, would rather tend to show that his mental faculties were in excellent working order than the reverse. Wendell Holmes tells a story which effectively illustrates our meaning; and he tells it so pleasantly (as usual) that we shall quote it unaltered: "Sometimes, but rarely," he says, "one may be caught making the same speech twice over, and yet be held blameless. Thus a certain lecturer" (Holmes himself, doubtless), "after performing in an inland city, where dwells a *littératrice* of note, was invited to meet her and others over the social teacup. She pleasantly referred to his many wanderings in his new occupation. 'Yes,' he replied, 'I am like the huma, the bird that never lights, being always in the cars as he is always on the wing.' Years elapsed. The lecturer visited the same place once more for the same purpose. Another social cup after the lecture, and a second meeting with the distinguished lady. 'You are constantly going from place to place,' she said. 'Yes,' he answered, 'I am like the huma,' and finished the sentence as before. What horrors, when it flashed over him that he had made this fine speech, word for word, twice over! Yet it was not true, as the lady might perhaps have fairly inferred, that he had embellished his conversation with the huma daily during that whole interval of years. On the contrary, he had never once thought of the odious fowl until the recurrence of precisely the same circumstances brought up precisely the same idea." He was not in the slightest degree afraid of brain-disease. On the contrary, he considered the circumstance indicative of good order in the mental mechanism. "He ought to have been proud," says Holmes, speaking for him, and meaning no doubt that he was proud, "of the accuracy of his mental adjustments. *Given certain factors, and a sound brain should always evolve the same fixed product with the certainty of Babbage's calculating machine.*"

Somewhat akin to the unconscious recurrence of mental processes after considerable intervals of time is the tendency to imitate the actions of others as though sharing in their thoughts, and according to many *because* mind acts upon mind. This tendency, though not always associated with disease, is usually a sign of bodily illness. Dr. Carpenter mentions the following singular case, but rather as illustrating generally the influence of suggestions derived from external sources in

determining the current of thought, than as showing how prone the thoughts are to run in undesirable currents when the body is out of health : "During an epidemic of fever, in which an active delirium had been a common symptom, it was observed that many of the patients of one particular physician were possessed by a strong tendency to throw themselves out of the window, while no such tendency presented itself in unusual frequency in the practice of others. The author's informant, Dr. C., himself a distinguished professor in the university, explained the tendency of what had occurred within his own knowledge ; he having been himself attacked by the fever, and having been under the care of this physician, his friend and colleague, Dr. A. Another of Dr. A.'s patients, whom we shall call Mr. B., seems to have been the first to make the attempt in question ; and, impressed with the necessity of taking due precautions, Dr. A. then visited Dr. C., *in whose hearing* he gave directions to have the windows properly secured, as Mr. B. had attempted to throw himself out. Now, Dr. C. distinctly remembers that, although he had not previously experienced any such desire, it came upon him with great urgency as soon as ever the idea was thus suggested to him ; his mind being just in that state of incipient delirium which is marked by the temporary dominance of some one idea, and by the want of volitional power to withdraw the attention from it. And he deemed it probable that, as Dr. A. went on to Mr. D., Mr. E., etc., and gave similar directions, a like desire would be excited in the minds of all those who might happen to be in the same impressible condition." The case is not only interesting as showing how the mind in disease receives certain impressions more strongly than in health, and, in a sense, may thus be said to possess for the time an abnormal power, but it affords a useful hint to doctors and nurses, who do not always (the latter indeed scarcely ever) consider the necessity of extreme caution when speaking about their patients and in their presence. It is probable that a considerable proportion of the accidents, fatal and otherwise, which have befallen delirious patients might be traced to incautious remarks made in their hearing by foolish nurses or forgetful doctors.

In some cases doctors have had to excite a strong antagonistic feeling against tendencies of this kind. Thus Zerffi relates that an English physician was once consulted by the mistress of a ladies' school where many girls had become liable to fits of hysterics. He tried several remedies, but in vain. At last, justly regarding the epidemic as arising from the influence of imagination on the weaker girls (one hysterical girl having infected the others), he determined to exert a stronger antagonistic influence on the weak minds of his patients. He therefore remarked casually to the mistress of the school, in the hearing of the girls, that he had now tried all methods but one, which he would try, as a last resource, when next he called—"the application of a red-hot iron to the spine of the patients so as to quiet their nervously excited

systems." "Strange to say," remarks Zerffi—meaning, no doubt, "it is hardly necessary to say that"—"the red-hot iron was never applied, for the hysterical attacks ceased as if by magic."

In another case mentioned by Zerffi, a revival mania in a large school near Cologne was similarly brought to an abrupt end. The Government sent an inspector. He found that the boys had visions of Christ, the Virgin, and departed saints. He threatened to close the school if these visions continued, and thus to exclude the students from all the prospects which their studies afforded them. "The effect was as magical as the red-hot iron remedy—the revivals ceased as if by magic."

The following singular cases are related in Zimmermann's "Solitude": A nun, in a very large convent in France, began to mew like a cat. At last all the nuns began to mew together every day at a certain time, and continued mewing for several hours together. This daily cat-concert continued until the nuns were informed that a company of soldiers was placed by the police before the entrance of the convent, and that the soldiers were provided with rods with which they would whip the nuns until they promised not to mew any more. . . . In the fifteenth century, a nun in a German convent fell to biting her companions. In the course of a short time all the nuns of this convent began biting each other. The news of this infatuation among the nuns soon spread, and excited the same elsewhere; the biting mania passing from convent to convent through a great part of Germany. It afterward visited the nunneries of Holland, and even spread as far as Rome." No suggestion of bodily disease is made in either case. But any one who considers how utterly unnatural is the manner of life in monastic communities will not need the evidence derived from the spread of such preposterous habits to be assured that in convents the perfectly sane mind in a perfectly healthy body must be the exception rather than the rule.

The dancing mania, which spread through a large part of Europe in the fourteenth and fifteenth centuries, although it eventually attacked persons who were seemingly in robust health, yet had its origin in disease. Dr. Hecker, who has given the most complete account we have of this strange mania, in his "Epidemics of the Middle Ages," says that when the disease was completely developed the attack commenced with epileptic convulsions. "Those affected fell to the ground senseless, panting and laboring for breath. They foamed at the mouth, and suddenly springing up began their dance amid strange contortions. They formed circles hand in hand, and appearing to have lost all control over their senses continued dancing, regardless of the bystanders, for hours together, in wild delirium, until at length they fell to the ground in a state of exhaustion. They then complained of extreme oppression, and groaned as if in the agonies of death, until they were swathed in clothes bound tightly round their waists; upon which they again recovered,

and remained free from complaint until the next attack . . . . While dancing they neither saw nor heard, being insensible to external impressions through the senses; but they were haunted by visions, their fancies conjuring up spirits, whose names they shrieked out; and some of them afterward asserted that they felt as if they had been immersed in a stream of blood, which obliged them to leap so high. Others during the paroxysm saw the heavens open, and the Saviour enthroned with the Virgin Mary, according as the religious notions of the age were strangely and variously reflected in their imaginations." The epidemic attacked people of all stations, but especially those who led a sedentary life, such as shoemakers and tailors; yet even the most robust peasants finally yielded to it. They "abandoned their labors in the fields as if they were possessed by evil spirits, and those affected were seen assembling indiscriminately from time to time, at certain appointed places, and, unless prevented by the lookers-on, continued to dance without intermission, until their very last breath was expended. Their fury and extravagance of demeanor so completely deprived them of their senses, that many of them dashed their brains out against the walls and corners of buildings, or rushed headlong into rapid rivers, where they found a watery grave. Roaring and foaming as they were, the bystanders could only succeed in restraining them by placing benches and chairs in their way, so that, by the high leaps they were thus tempted to take, their strength might be exhausted. As soon as this was the case they fell, as it were, lifeless to the ground, and by very slow degrees recovered their strength. Many there were who even with all this exertion had not expended the violence of the tempest which raged within them, but awoke with newly revived powers and again and again mixed with the crowd of dancers; until at length the violent excitement of their disordered nerves was allayed by the great involuntary exertion of their limbs, and the mental disorder was calmed by the exhaustion of the body. The cure effected by these stormy attacks was in many cases so perfect that some patients returned to the factory or plow, as if nothing had happened. Others, on the contrary, paid the penalty of their folly by so total a loss of power that they could not regain their former health, even by the employment of the most strengthening remedies."

It may be doubted, perhaps, by some whether such instances as these illustrate so much the state to which the mind is reduced when the body is diseased, as the state to which the body is reduced when the mind is diseased, though, as we have seen, the dancing mania when fully developed followed always on bodily illness. In the cases we now have to deal with, the diseased condition of the body was unmistakable.

Mrs. Hemans on her death-bed said that it was impossible for imagination to picture or pen to describe the delightful visions which passed before her mind. They made her waking hours more delightful than those passed in sleep. It is evident that these visions had their origin in the

processes of change affecting the substance of the brain as the disease of the body progressed. But it does not follow that the substance of the brain was undergoing changes necessarily tending to its ultimate decay and dissolution. Quite possibly the changes were such as might occur under the influence of suitable medicinal or stimulant substances, and without any subsequent ill effects. Dr. Richardson, in an interesting article on ether-drinking and extra-alcoholic intoxication ("Gentleman's Magazine" for October), makes a remark which suggests that the medical men of our day look forward to the discovery of means for obtaining some such influence over the action of the brain. After describing the action of methylic and ethylic ethers in his own case, he says: "They who have felt this condition, who have lived, as it were, in another life, however transitorily, are easily led to declare with Davy that 'nothing exists but thoughts! the universe is composed of impressions, ideas, pleasures, and pains!' I believe that it is so, and that we might by scientific art, and there is such an art, learn to live altogether in a new sphere of impressions, ideas, pleasures, and pains. . . . But stay," he adds, as if he had said too much, "I am anticipating, unconsciously, something else that is in my mind. The rest is silence; I must return to the world in which we now live, and which all know."

Mr. Butterworth mentions the case of the Rev. William Tennent, of Freehold, New Jersey, as illustrative of strange mental faculties possessed during disease. Tennent was supposed to be far gone in consumption. At last, after a protracted illness, he seemingly died, and preparations were made for his funeral. Not only were his friends deceived, but he was deceived himself, for he thought he was dead, and that his spirit had entered paradise. "His soul, as he thought, was borne aloft to celestial altitudes, and was enraptured by visions of God and all the hosts of heaven. He seemed to dwell in an enchanted region of limitless light and inconceivable splendor. At last an angel came to him and told him that he must go back. Darkness, like an overawing shadow, shut out the celestial glories; and, full of sudden horror, he uttered a deep groan. This dismal utterance was heard by those around him, and prevented him from being buried alive, after all the preparations had been made for the removal of the body."

We must not fall into the mistake of supposing, however, as many seem to do, that the visions seen under such conditions, or by ecstatics, really present truths of which the usual mental faculties could not become cognizant. We have heard such cases as the death-bed visions of Mrs. Hemans, and the trance visions of Tennent, urged as evidence in favor of special forms of doctrine. We have no thought of attacking these, but assuredly they derive no support from evidence of this sort. The dying Hindoo has visions which the Christian would certainly not regard as heaven-born. The Mohammedan sees the plains of paradise, peopled by the houris of his heaven, but we do not on that account accept the Koran as the sole guide to religious truth. The fact is, that

the visions pictured by the mind during the disease of the body, or in the ecstatic condition, have their birth in the mind itself, and take their form from the teachings with which that mind has been imbued. They may, indeed, seem utterly unlike those we should expect from the known character of the visionary, just as the thoughts of a dying man may be, and often are, very far removed from the objects which had occupied all his attention during the later years of his life. But if the history of the childhood and youth of an ecstatic could be fully known, or if (which is exceedingly unlikely) we could obtain a strictly truthful account of such matters from himself, we should find nearly every circumstance of his visions explained, or at least an explanation suggested. For, after all, much which would be necessary to exactly show the origin of all he saw, would be lost, since the brain retains impressions of many things of which the conscious memory has entirely passed away.

The vivid picturing of forgotten events of life is a familiar experience of the opium-eater. Thus De Quincey says: "The minutest incidents of childhood, or forgotten scenes of later years, were often revived. I could not be said to recollect them, for, if I had been told of them when waking, I should not have been able to acknowledge them as part of my past experience. But placed as they were before me in dreams like intuitions and clothed in all their evanescent circumstances and accompanying feelings, I recognized them instantaneously." A similar return of long-forgotten scenes and incidents to the mind may be noticed, though not to the same degree, when wine has been taken in moderate quantity after a long fast.

The effects of hasheesh are specially interesting in this connection, because, unless a very powerful dose has been taken, the hachischin does not wholly lose the power of introspection, so that he is able afterward to recall what has passed through his mind when he was under the influence of the drug. Now Moreau, in his interesting "Études Psychologiques" ("Du Hachich et d'Aliénation Mentale"), says that the first result of a dose sufficient to produce the *hasheesh fantasia* is a feeling of intense happiness. "It is really *happiness* which is produced by the hasheesh; and by this simply an enjoyment entirely moral, and by no means sensual as we might be induced to suppose. This is surely a very curious circumstance; and some remarkable inferences might be drawn from it; this, for instance, among others—that every feeling of joy and gladness, even when the cause of it is exclusively moral—that those enjoyments which are least connected with material objects, the most spiritual, the most ideal, may be nothing else than sensations purely physical, developed in the interior of the system, as are those procured by hasheesh. At least so far as relates to that of which we are internally conscious, there is no distinction between these two orders of sensations, in spite of the diversity in the causes to which they are due; for the hasheesh-eater is happy, not like the gourmand or the famished man when satisfying his appetite, or the voluptuary in grati-

fying his amative desires, but like him who hears tidings which fill him with joy, like the miser counting his treasures, the gambler who is successful at play, or the ambitious man who is intoxicated with success."

Our special object, however, in noting the effects of opium and hasheesh, is rather to note how the mental processes or faculties observed during certain states of disease may be produced artificially, than to enter into the considerations discussed by Dr. Moreau. It is singular that while the Mohammedan order of Hachischin (or Assassins) bring about by the use of their favorite drug such visions as accompany the progress of certain forms of disease, the Hindoo devotees called the Yogi are able to produce artificially the state of mind and body recognized in cataleptic patients. The less advanced Yogi can only enter the state of abstraction called reverie; but the higher orders can simulate absolute inanition, the heart apparently ceasing to beat, the lungs to act, and the nerves to convey impressions to the brain, even though the body be subjected to processes which would cause extreme torture under ordinary conditions. "When in this state," says Carpenter, "the Yogi are supposed to be completely possessed by Brahma, 'the supreme soul,' and to be incapable of sin in thought, word, or deed." It has been supposed that this was the state into which those entered who in old times were resorted to as oracles. But it has happened that in certain stages of disease the power of assuming the death-like state has been possessed for a time. Thus Colonel Townsend, who died in 1797, we read, had in his last sickness the extraordinary power of apparently dying and returning to life again at will. "I found his pulse sink gradually," says Dr. Cheyne, who attended him, "so that I could not feel it by the most exact or nice touch. Dr. Raymond could not detect the least motion of the heart, nor Dr. Skrine the least soil of the breath upon the bright mirror held to the mouth. We began to fear he was actually dead. He then began to breathe softly." Colonel Townsend repeated the experiment several times during his illness, and could always render himself insensible at will.

Lastly, we may mention a case, which, however, though illustrating in some degree the influence of bodily illness on the mind, shows still more strikingly how the mind may influence the body—that of Louise Lateau, the Belgian peasant. This girl had been prostrated by a long and exhausting illness, from which she recovered rapidly after receiving the sacrament. This circumstance made a strong impression on her mind. Her thoughts dwelt constantly on the circumstances attending the death of Christ. At length she noticed that, on every Friday, blood came from a spot in her left side. "In the course of a few months similar bleeding spots established themselves on the front and back of each hand, and on the upper surface of each foot, while a circle of small spots formed in the forehead, and the hæmorrhage from these recurred every Friday, sometimes to a considerable amount. About the same time, fits of ecstasy began to occur, commencing every Friday between eight and

nine in the morning, and ending about six in the evening; interrupting her in conversation, in prayer, or in manual occupations. This state," says Dr. Carpenter, "appears to have been intermediate between that of the biologized and that of the hypnotized subject; for, while as unconscious as the latter of all sense-impressions, she retained, like the former, a recollection of all that had passed through her mind during the ecstasy. She described herself as suddenly plunged into a vast flood of bright light, from which more or less distinct forms began to evolve themselves; and she then witnessed the several scenes of the Passion successively passing before her. She minutely described the cross and the vestments, the wounds, the crown of thorns about the head of the Saviour, and gave various details regarding the persons about the cross, the disciples, holy women, Jews, and Roman soldiers. And the progress of her vision might be traced by the succession of actions she performed at various stages of it: most of these movements expressive of her own emotions, while regularly about three in the afternoon she extended her limbs in the form of a cross. The fit terminated with a state of extreme physical prostration; the pulse being scarcely perceptible, the breathing slow and feeble, and the whole surface bedewed with a cold perspiration. After this state had continued for about ten minutes, a return to the normal condition rapidly took place."

There seems no reason for supposing that there was any deceit on the part of Louise Lateau herself, though that she was self-deceived no one can reasonably doubt. Of course many in Belgium, especially the more ignorant and superstitious (including large numbers of the clergy and of religious orders of men and women), believed that her ecstasies were miraculous, and no doubt she believed so herself. But none of the circumstances observed in her case, or related by her, were such as the physiologist would find any difficulty in accepting or explaining. Her visions were such as might have been expected in a person of her peculiar nervous organization, weakened as her body had been by long illness, and her mind affected by what she regarded as her miraculous recovery. As to the transudation of blood from the skin, Dr. Tuke, in his "Illustrations of the Influence of the Mind upon the Body in Health and Disease" (p. 267), shows the phenomenon to be naturally explicable. It is a well-authenticated fact that under strong emotional excitement blood escapes through the perspiratory ducts, apparently through the rupture of the walls of the capillary passages of the skin.

We see, then, in Louise Lateau's case, how the mind affected by disease may acquire faculties not possessed during health, and how in turn the mind thus affected may influence the body so strangely as to suggest to ignorant or foolish persons the operation of supernatural agencies. Of the influence of the mind on the body, we may speak more fully on another occasion.

The general conclusion to which we seem led by the observed pecu-

liarities in the mental faculties during disease is that the mind depends greatly on the state of the body for the coördination of its various powers. In health these are related in what may be called the normal manner. Faculties capable of great development under other conditions exist in moderate degree only, while probably, either consciously or unconsciously, certain faculties are held in control by others. But during illness faculties, not ordinarily used, suddenly or very rapidly acquire undue predominance, and controlling faculties usually effective are greatly weakened. Then for a while the mental capacity seems entirely changed. Powers supposed not to exist at all (for of mental faculties, as of certain other qualities, *de non existentibus et de non apparentibus eadem est ratio*) seem suddenly created, as if by a miracle. Faculties ordinarily so strong as to be considered characteristic seem suddenly destroyed, since they no longer produce any perceptible effect. Or, as Brown-Séquard says, summing up the results of a number of illustrative cases described in a course of lectures delivered in Boston, "It would seem that the mind is largely dependent on physical conditions for the exercise of its faculties, and that its strength and most remarkable powers, as well as its apparent weakness, are often most clearly shown and recognized by some inequality of action in periods of disturbed and greatly impaired health."—*Cornhill Magazine.*

ON SENSATION AND THE UNITY OF STRUCTURE OF SENSIFEROUS ORGANS.

By Professor T. H. HUXLEY.

THE maxim that metaphysical inquiries are barren of result, and that the serious occupation of the mind with them is a mere waste of time and labor, finds much favor in the eyes of the many persons who pride themselves on the possession of sound common sense; and we sometimes hear it enunciated by weighty authorities, as if its natural consequence, the suppression of such studies, had the force of a moral obligation.

In this case, however, as in some others, those who lay down the law seem to forget that a wise legislator will consider, not merely whether his proposed enactment is desirable, but whether obedience to it is possible. For, if the latter question is answered negatively, the former is surely hardly worth debate.

Here, in fact, lies the pith of the reply to those who would make metaphysics contraband of intellect. Whether it is desirable to place a prohibitory duty upon philosophical speculations or not, it is utterly impossible to prevent the importation of them into the mind. And it

is not a little curious to observe that those who most loudly profess to abstain from such commodities are all the while unconscious consumers, on a great scale, of one or other of their multitudinous disguises or adulterations. With mouths full of the particular kind of heavily buttered toast which they affect, they inveigh against the eating of plain bread. In truth, the attempt to nourish the human intellect upon a diet which contains no metaphysics is about as hopeful as that of certain Eastern sages to nourish their bodies without destroying life. Everybody has heard the story of the pitiless microscopist, who ruined the peace of mind of one of these mild enthusiasts by showing him the animals moving in a drop of the water with which, in the innocency of his heart, he slaked his thirst; and the unsuspecting devotee of plain common sense may look for as unexpected a shock when the magnifier of severe logic reveals the germs, if not the full-grown shapes, of lively metaphysical postulates rampant amid his most positive and matter-of-fact notions.

By way of escape from the metaphysical Will-o'-the-wisps generated in the marshes of literature and theology, the serious student is sometimes bidden to betake himself to the solid ground of physical science. But the fish of immortal memory, who threw himself out of the frying-pan into the fire, was not more ill advised than the man who seeks sanctuary from philosophical persecution within the walls of the observatory or of the laboratory. It is said that "metaphysics" owe their name to the fact that, in Aristotle's works, questions of pure philosophy are dealt with immediately after those of physics. If so, the accident is happily symbolical of the essential relations of things; for metaphysical speculation follows as closely upon physical theory as black care upon the horseman.

One need but mention such fundamental, and indeed indispensable, conceptions of the natural philosopher as those of atoms and forces; or that of attraction considered as action at a distance; or that of potential energy; or the antinomies of a vacuum and a plenum; to call to mind the metaphysical background of physics and chemistry; while, in the biological sciences, the case is still worse. What is an individual among the lower plants and animals? Are genera and species realities or abstractions? Is there such a thing as Vital Force? or does the name denote a mere relic of metaphysical fetichism? Is the doctrine of final causes legitimate or illegitimate? These are a few of the metaphysical topics which are suggested by the most elementary study of biological facts. But, more than this, it may be truly said that the roots of every system of philosophy lie deep among the facts of physiology. No one can doubt that the organs and the functions of Sensation are as much a part of the province of the physiologist as are the organs and functions of motion, or those of digestion; and yet it is impossible to gain an acquaintance with even the rudiments of the physiology of sensation without being led straight to one of the most fundamental of all

metaphysical problems. In fact, the sensory operations have been, from time immemorial, the battle-ground of philosophers.

I have more than once taken occasion to point out that we are indebted to Descartes, who happened to be a physiologist as well as a philosopher, for the first distinct enunciation of the essential elements of the true theory of sensation. In later times, it is not to the works of the philosophers, if Hartley and James Mill are excepted, but to those of the physiologists, that we must turn for an adequate account of the sensory process. Haller's luminous, though summary, account of sensation in his admirable "Primæ Lineæ," the first edition of which was printed in 1747, offers a striking contrast to the prolixity and confusion of thought which pervade Reid's "Inquiry," of seventeen years' later date.* Even Sir William Hamilton, learned historian and acute critic as he was, not only failed to apprehend the philosophical bearing of long-established physiological truths; but, when he affirmed that there is no reason to deny that the mind feels at the finger-points, and none to assert that the brain is the sole organ of thought,† he showed that he had not apprehended the significance of the revolution commenced, two hundred years before his time, by Descartes, and effectively followed up by Haller, Hartley, and Bonnet, in the middle of the last century.

In truth, the theory of sensation, except in one point, is, at the present moment, very much where Hartley, led by a hint of Sir Isaac Newton's, left it, when, a hundred and twenty years since, the "Observations on Man: his Frame, his Duty, and his Expectations," was laid before the world. The whole matter is put in a nutshell in the following passages of this notable book:

External objects impressed upon the senses occasion, first on the nerves on which they are impressed, and then on the brain, vibrations of the small and, as we may say, infinitesimal medullary particles.

These vibrations are motions backward and forward of the small particles;

* In justice to Reid, however, it should be stated that the chapters on Sensation in the "Essays on the Intellectual Powers" (1785) exhibit a great improvement. He is, in fact, in advance of his commentator, as the note to Essay II., chap. ii., p. 248 of Hamilton's edition shows.

† Haller, amplifying Descartes, writes in the "Primæ Lineæ," CCCXVI.: "Non est adeo obscurum sensum omnem oriri ab objecti sensibilis impressione in nervum quemcumque corporis humani, et eamdem per eum nervum ad cerebrum pervenientem tunc demum representari animæ, quando cerebrum adtigit. Ut etiam hoc falsum sit animam inproximo per sensoria nervorumque ramos sentire." . . . DLVII.: "Dum ergo sentimus quinque diversissima entia conjunguntur: corpus quod sentimus: organi sensorii adfectio ab eo corpore: cerebri adfectio a sensorii percussione nata: in anima nata mutatio: animæ denique conscientia et sensationis adperceptio." Nevertheless, Sir William Hamilton gravely informs his hearers: "We have no more right to deny that the mind feels at the finger-points, as consciousness assures us, than to assert that it thinks exclusively in the brain."—"Lecture on Metaphysics and Logic," ii., p. 128. "We have no reason whatever to doubt the report of consciousness, that we actually perceive at the external point of sensation, and that we perceive the material reality."—Ibid., p. 129.

of the same kind with the oscillations of pendulums and the tremblings of the particles of sounding bodies. They must be conceived to be exceedingly short and small, so as not to have the least efficacy to disturb or move the whole bodies of the nerves or brain.*

The white medullary substance of the brain is also the immediate instrument by which ideas are presented to the mind; or, in other words, whatever changes are made in this substance, corresponding changes are made in our ideas; and *vice versa*.†

Hartley, like Haller, had no conception of the nature and functions of the gray matter of the brain. But, if for "white medullary substance," in the latter paragraph, we substitute "gray cellular substance," Hartley's propositions embody the most probable conclusions which are to be drawn from the latest investigations of physiologists. In order to judge how completely this is the case, it will be well to study some simple case of sensation, and, following the example of Reid and of James Mill, we may begin with the sense of smell. Suppose that I become aware of a musky scent, to which the name of "muskiness" may be given. I call this an odor, and I class it along with the feelings of light, colors, sounds, tastes, and the like, among those phenomena which are known as sensations. To say that I am aware of this phenomenon, or that I have it, or that it exists, are simply different modes of affirming the same facts. If I am asked how I know that it exists, I can only reply that its existence and my knowledge of it are one and the same thing; in short, that my knowledge is immediate or intuitive, and, as such, is possessed of the highest conceivable degree of certainty.

The pure sensation of muskiness is almost sure to be followed by a mental state which is not a sensation, but a belief, that there is somewhere close at hand a something on which the existence of the sensation depends. It may be a musk-deer, or a musk-rat, or a musk-plant, or a grain of dry musk, or simply a scented handkerchief; but former experience leads us to believe that the sensation is due to the presence of one or other of these objects, and that it will vanish if the object is removed. In other words, there arises a belief in an external cause of the muskiness, which, in common language, is termed an odorous body.

But the manner in which this belief is usually put into words is strangely misleading. If we are dealing with a musk-plant, for example, we do not confine ourselves to a simple statement of that which we believe, and say that the musk-plant is the cause of the sensation called muskiness; but we say that the plant has a musky smell, and we speak of the odor as a quality, or property, inherent in the plant.

* "Observations on Man," vol. i., p. 11.

† Ibid., p. 8. The speculations of Bonnet are remarkably similar to those of Hartley; and they appear to have originated independently, though the "Essai de Psychologie" (1754) is of five years' later date than the "Observations on Man" (1749).

And the inevitable reaction of words upon thought has in this case become so complete, and has penetrated so deeply, that when an accurate statement of the case—namely, that muskiness, inasmuch as the term denotes nothing but a sensation, is a mental state and has no existence except as a mental phenomenon—is first brought under the notice of common-sense folks, it is usually regarded by them as what they are pleased to call a mere metaphysical paradox and a patent example of useless subtilty. Yet the slightest reflection must suffice to convince any one possessed of sound reasoning faculties that it is as absurd to suppose that muskiness is a quality inherent in one plant, as it would be to imagine that pain is a quality inherent in another, because we feel pain when a thorn pricks the finger.

Even the common-sense philosopher, *par excellence*, says of smell: "It appears to be a simple and original affection or feeling of the mind, altogether inexplicable and unaccountable. It is, indeed, impossible that it can be in any body: it is a sensation, and a sensation can only be in a sentient thing."*

That which is true of muskiness is true of every other odor. Lavender-smell, clove-smell, garlic-smell, are, like "muskiness," names of states of consciousness, and have no existence except as such. But, in ordinary language, we speak of all these odors as if they were independent entities residing in lavender, cloves, and garlic; and it is not without a certain struggle that the false metaphysic of common sense, thus ingrained in us, is expelled.

It is unnecessary for the present purpose to inquire into the origin of our belief in external bodies, or into that of the notion of causation. Assuming the existence of an external world, there is no difficulty in obtaining experimental proof that, as a general rule, olfactory sensations are caused by odorous bodies; and we may pass on to the next step of the inquiry—namely, how the odorous body produces the effect attributed to it.

The first point to be noted here is another fact revealed by experience; that the appearance of the sensation is governed, not only by the presence of the odorous substance, but by the condition of a certain part of our corporeal structure, the nose. If the nostrils are closed, the presence of the odorous substance does not give rise to the sensation; while, when they are open, the sensation is intensified by the approximation of the odorous substance to them, and by snuffing up the adjacent air in such a manner as to draw it into the nose. On the other

* "An Inquiry into the Human Mind on the Principles of Common Sense, chap. ii., sec. 2. Reid affirms that "it is genius and not the want of it that adulterates philosophy, and fills it with error and false theory"; and no doubt his own lucubrations are free from the smallest taint of the impurity to which he objects. But, for want of something more than that "common sense," which is very common and a little dull, the contemner of genius did not notice that the admission here made knocks so big a hole in the bottom of "common-sense philosophy" that nothing can save it from foundering in the dreaded abyss of Idealism.

hand, looking at an odorous substance, or rubbing it on the skin, or holding it to the ear, does not awaken the sensation. Thus, it can be readily established by experiment that the perviousness of the nasal passages is, in some way, essential to the sensory function; in fact, that the organ of that function is lodged somewhere in the nasal passages. And, since odorous bodies give rise to their effects at considerable distances, the suggestion is obvious that something must pass from them into the sense-organ. What is this something which plays the part of an intermediary between the odorous body and the sensory organ?

The oldest speculation about the matter dates back to Democritus and the Epicurean school, and it is to be found fully stated in the fourth book of Lucretius. It comes to this: that the surfaces of bodies are constantly throwing off excessively attenuated films of their own substance; and that these films, reaching the mind, excite the appropriate sensations in it.

Aristotle did not admit the existence of any such material films, but conceived that it was the form of the substance, and not its matter, which affected sense, as a seal impresses wax, without losing anything in the process. While many, if not the majority, of the schoolmen took up an intermediate position, and supposed that a something which was not exactly either material or immaterial, and which they called an "intentional species," effected the needful communication between the bodily cause of sensation and the mind.

But all these notions, whatever may be said for or against them in general, are fundamentally defective, by reason of an oversight which was inevitable, in the state of knowledge at the time in which they were promulgated. What the older philosophers did not know, and could not know, before the anatomist and physiologist had done his work, is that, between the external object and that mind in which they supposed the sensation to inhere, there lies a physical obstacle. The sense-organ is not a mere passage by which the "tenuia simulacra rerum," or the "intentional species" cast off by objects, or the "forms" of sensible things, pass straight to the mind; on the contrary, it stands as a firm and impervious barrier, through which no material particle of the world without can make its way to the world within.

Let us consider the olfactory sense-organ more nearly. Each of the nostrils leads into a passage completely separated from the other by a partition, and these two passages place the nostrils in free communication with the back of the throat, so that they freely transmit the air passing to the lungs when the mouth is shut, as in ordinary breathing. The floor of each passage is flat, but its roof is a high arch, the crown of which is seated between the orbital cavities of the skull, which serve for the lodgment and protection of the eyes; and therefore lies behind the apparent limits of that feature which in ordinary language is called the nose. From the side walls of the upper and back part of these

arched chambers certain delicate plates of bone project, and these, as well as a considerable part of the partition between the two chambers, are covered by a fine, soft, moist membrane. It is to this Schneiderian, or olfactory, membrane that odorous bodies must obtain direct access if they are to give rise to their appropriate sensations; and it is upon the relatively large surface which the olfactory membrane offers that we must seek for the seat of the organ of the olfactory sense. The only essential part of that organ consists of a multitude of minute, rod-like bodies, set perpendicularly to the surface of the membrane, and forming a part of the cellular coat, or epithelium, which covers the olfactory membrane, as the epidermis covers the skin. In the case of the olfactory sense, there can be no doubt that the Democritic hypothesis, at any rate for such odorous substances as musk, has a good foundation. Infinitesimal particles of musk fly off from the surface of the odorous body, and, becoming diffused through the air, are carried into the nasal passages, and thence into the olfactory chambers, where they come into contact with the filamentous extremities of the delicate olfactory epithelium.

But this is not all. The "mind" is not, so to speak, upon the other side of the epithelium. On the contrary, the inner ends of the olfactory cells are connected with nerve-fibers, and these nerve-fibers, passing into the cavity of the skull, at length end in a part of the brain, the olfactory sensorium. It is certain that the integrity of each, and the physical interconnection of all these three structures, the epithelium of the sensory organ, the nerve-fibers, and the sensorium, are essential conditions of ordinary sensation. That is to say, the air in the olfactory chambers may be charged with particles of musk; but, if either the epithelium, or the nerve-fibers, or the sensorium is injured, or physically disconnected from one another, sensation will not arise. Moreover, the epithelium may be said to be receptive, the nerve-fibers transmissive, and the sensorium sensifacient. For, in the act of smelling, the particles of the odorous substance produce a molecular change (which Hartley was in all probability right in terming a vibration) in the epithelium, and this change, being transmitted to the nerve-fibers, passes along them with a measurable velocity, and, finally reaching the sensorium, is immediately followed by the sensation.

Thus, modern investigation supplies a representative of the Epicurean simulacra in the volatile particles of the musk; but it also gives us the stamp of the particles on the olfactory epithelium, without any transmission of matter, as the equivalent of the Aristotelian "form"; while, finally, the modes of motion of the molecules of the olfactory cell, of the nerve, and of the cerebral sensorium, which are Hartley's vibrations, may stand very well for a double of the "intentional species" of the schoolmen. And this last remark is not intended merely to suggest a fanciful parallel; for, if the cause of the sensation is, as analogy suggests, to be sought in the mode of motion of the object of sense,

then it is quite possible that the particular mode of motion of the object is reproduced in the sensorium; exactly as the diaphragm of a telephone reproduces the mode of motion taken up at its receiving end. In other words, the secondary "intentional species" may be, as the schoolmen thought the primary one was, the last link between matter and mind.

None the less, however, does it remain true that no similarity exists, nor indeed is conceivable, between the cause of the sensation and the sensation. Attend as closely to the sensations of muskiness, or any other odor, as we will, no trace of extension, resistance, or motion is discernible in them. They have no attribute in common with those which we ascribe to matter; they are, in the strictest sense of the words, immaterial entities.

Thus, the most elementary study of sensation justifies Descartes's position, that we know more of mind than we do of body; that the immaterial world is a firmer reality than the material. For the sensation "muskiness" is known immediately. So long as it persists, it is a part of what we call our thinking selves, and its existence lies beyond the possibility of doubt. The knowledge of an objective or material cause of the sensation, on the other hand, is mediate; it is a belief as contradistinguished from an intuition; and it is a belief which, in any given instance of sensation, may, by possibility, be devoid of foundation. For odors, like other sensations, may arise from the occurrence of the appropriate molecular changes in the nerve or in the sensorium, by the operation of a cause distinct from the affection of the sense-organ by an odorous body. Such "subjective" sensations are as real existences as any others, and as distinctly suggest an external odorous object as their cause; but the belief thus generated is a delusion. And, if beliefs are properly termed "testimonies of consciousness," then undoubtedly the testimony of consciousness may be, and often is, untrustworthy.

Another very important consideration arises out of the facts as they are now known. That which, in the absence of a knowledge of the physiology of sensation, we call the cause of the smell, and term the odorous object, is only such, mediately, by reason of its emitting particles which give rise to a mode of motion in the sense-organ. The sense-organ, again, is only a mediate cause by reason of its producing a molecular change in the nerve-fiber; while this last change is also only a mediate cause of sensation, depending, as it does, upon the change which it excites in the sensorium.

The sense-organ, the nerve, and the sensorium, taken together, constitute the sensiferous apparatus. They make up the thickness of the wall between the mind, as represented by the sensation "muskiness," and the object, as represented by the particle of musk in contact with the olfactory epithelium.

It will be observed that the sensiferous wall and the external world are of the same nature; whatever it is that constitutes them both is expressible in terms of matter and motion. Whatever changes take place

in the sensiferous apparatus are continuous with, and similar to, those which take place in the external world.* But, with the sensorium, matter and motion come to an end; while phenomena of another order, or immaterial states of consciousness, make their appearance. How is the relation between the material and the immaterial phenomena to be conceived? This is the metaphysical problem of problems, and the solutions which have been suggested have been made the corner-stones of systems of philosophy. Three mutually irreconcilable readings of the riddle have been offered.

The first is, that an immaterial substance of mind exists; and that it is affected by the mode of motion of the sensorium in such a way as to give rise to the sensation.

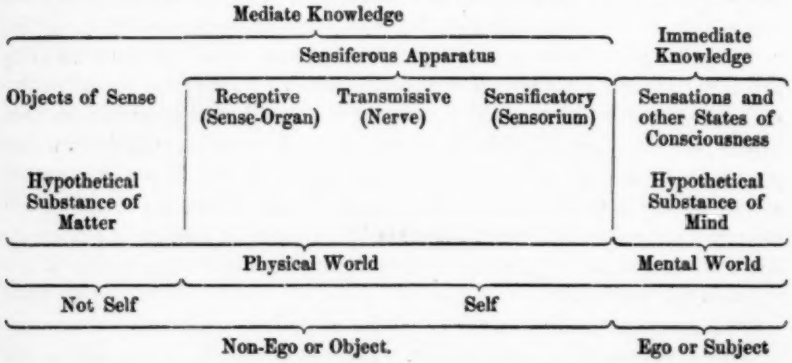
The second is, that the sensation is a direct effect of the mode of motion of the sensorium, brought about without the intervention of any substance of mind.

The third is, that the sensation is neither directly, nor indirectly, an effect of the mode of motion of the sensorium, but that it has an independent cause. Properly speaking, therefore, it is not an effect of the motion of the sensorium, but a concomitant of it.

As none of these hypotheses is capable of even an approximation to demonstration, it is almost needless to remark that they have been severally held with tenacity and advocated with passion. I do not think it can be said of any of the three that it is inconceivable, or that it can be assumed on *a priori* grounds to be impossible.

Consider the first, for example; an immaterial substance is perfectly conceivable. In fact, it is obvious that, if we possessed no sensations

* The following diagrammatic scheme may help to elucidate the theory of sensation:



Immediate Knowledge is confined to states of consciousness, or, in other words, to the phenomena of mind. Knowledge of the physical world, or of one's own body and of objects external to it, is a system of beliefs or judgments based on the sensations. The term "self" is applied not only to the series of mental phenomena which constitute the ego, but to the fragment of the physical world which is their constant concomitant. The corporeal self, therefore, is part of the non-ego; and is objective in relation to the ego as subject.

but those of smell and hearing, we should be unable to conceive a material substance. We might have a conception of time, but could have none of extension, or of resistance, or of motion. And without the three latter conceptions no idea of matter could be formed. Our whole knowledge would be limited to that of a shifting succession of immaterial phenomena. But, if an immaterial substance may exist, it may have any conceivable properties; and sensation may be one of them. All these propositions may be affirmed with complete dialectic safety, inasmuch as they can not possibly be disproved; but neither can a particle of demonstrative evidence be offered in favor of them.

As regards the second hypothesis, it certainly is not inconceivable, and therefore it may be true, that sensation is the direct effect of certain kinds of bodily motion. It is just as easy to suppose this as to suppose, on the former hypothesis, that bodily motion affects an immaterial substance. But neither is it susceptible of proof.

And, as to the third hypothesis, since the logic of induction is in no case competent to prove that events apparently standing in the relation of cause and effect may not both be effects of a common cause—that also is as safe from refutation, if as incapable of demonstration, as the other two.

In my own opinion, neither of these speculations can be regarded seriously as anything but a more or less convenient working hypothesis. But, if I must choose among them, I take the "law of parcimony" for my guide, and select the simplest—namely, that the sensation is the direct effect of the mode of motion of the sensorium. It may justly be said that this is not the slightest explanation of sensation; but then am I really any the wiser, if I say that a sensation is an activity (of which I know nothing) of a substance of mind (of which also I know nothing)? Or, if I say that the Deity causes the sensation to arise in my mind immediately after he has caused the particles of the sensorium to move in a certain way, is anything gained? In truth, a sensation, as we have already seen, is an intuition—a part of immediate knowledge. As such it is an ultimate fact and inexplicable; and all that we can hope to find out about it, and that indeed is worth finding out, is its relation to other natural facts. That relation appears to me to be sufficiently expressed, for all practical purposes, by saying that sensation is the invariable consequent of certain changes in the sensorium—or, in other words, that, so far as we know, the change in the sensorium is the cause of the sensation.

I permit myself to imagine that the untutored, if noble, savage of common sense who has been misled into reading thus far by the hope of getting positive solid information about sensation, giving way to not unnatural irritation, may here interpellate: "The upshot of all this long disquisition is, that we are profoundly ignorant. We knew that to begin with, and you have merely furnished another example of the emptiness and uselessness of metaphysics." But I venture to reply,

pardon me, you were ignorant, but you did not know it. On the contrary, you thought you knew a great deal, and were quite satisfied with the particularly absurd metaphysical notions which you were pleased to call the teachings of common sense. You thought that your sensations were properties of external things, and had an existence outside of yourself. You thought that you knew more about material than you do about immaterial existences. And if, as a wise man has assured us, the knowledge of what we don't know is the next best thing to the knowledge of what we do know, this brief excursion into the province of philosophy has been highly profitable.

Of all the dangerous mental habits, that which schoolboys call "cocksureness" is probably the most perilous; and the inestimable value of metaphysical discipline is, that it furnishes an effectual counterpoise to this evil proclivity. Whoso has mastered the elements of philosophy knows that the attribute of unquestionable certainty appertains only to the existence of a state of consciousness so long as it exists; all other beliefs are mere probabilities of a higher or lower order. Sound metaphysic is an amulet which renders its possessor proof alike against the poison of superstition and the counter-poison of nihilism; by showing that the affirmations of the former and the denials of the latter alike deal with matters about which, for lack of evidence, nothing can be either affirmed or denied.

I have dwelt at length upon the nature and origin of our sensations of smell, on account of the comparative freedom of the olfactory sense from the complications which are met with in most of the other senses.

Sensations of taste, however, are generated in almost as simple a fashion as those of smell. In this case, the sense-organ is the epithelium which covers the tongue and the palate; and which sometimes, becoming modified, gives rise to peculiar organs termed "gustatory bulbs," in which the epithelial cells elongate and assume a somewhat rod-like form. Nerve-fibers connect the sensory organ with the sensorium, and tastes or flavors are states of consciousness caused by the change of molecular state of the latter. In the case of the sense of touch there is often no sense-organ distinct from the general epidermis. But many fishes and amphibia exhibit local modifications of the epidermic cells which are sometimes extraordinarily like the gustatory bulbs; more commonly, both in lower and higher animals, the effect of the contact of external bodies is intensified by the development of hair-like filaments, or of true hairs, the bases of which are in immediate relation with the ends of the sensory nerves. Every one must have noticed the extreme delicacy of the sensations produced by the contact of bodies with the ends of the hairs of the head; and the "whiskers" of cats owe their functional importance to the abundant supply of nerves to the follicles in which their bases are lodged. What part, if any, the so-called "tactile corpuscles," "end-bulbs," and "Pacinian bodies" play

in the mechanism of touch is unknown. If they are sense-organs, they are exceptional in character, in so far as they do not appear to be modifications of the epidermis. Nothing is known respecting the sense-organs of those sensations of resistance which are grouped under the head of the muscular sense; nor of the sensations of warmth and cold; nor of that very singular sensation which we call tickling.

In the case of heat and cold, the organism not only becomes affected by external bodies, far more remote than those which affect the sense of smell, but the Democritic hypothesis is obviously no longer permissible. When the direct rays of the sun fall upon the skin, the sensation of heat is certainly not caused by "attenuated films" thrown off from that luminary, but to a mode of motion which is transmitted to us. In Aristotelian phrase, it is the form without the matter of the sun which stamps the sense-organ; and this, translated into modern language, means nearly the same thing as Hartley's vibrations. Thus we are prepared for what happens in the case of the auditory and the visual senses. For neither the ear nor the eye receives anything but the impulses or vibrations originated by sonorous or luminous bodies. Nevertheless, the receptive apparatus still consists of nothing but specially modified epithelial cells. In the labyrinth of the ear of the higher animals the free ends of these cells terminate in excessively delicate hair-like filaments; while, in the lower forms of auditory organ, its free surface is beset with delicate hairs like those of the surface of the body, and the transmissive nerves are connected with the bases of these hairs. Thus there is an insensible gradation in the forms of the receptive apparatus, from the organ of touch, on the one hand, to those of taste and smell; and, on the other hand, to that of hearing. Even in the case of the most refined of all the sense-organs, that of vision, the receptive apparatus departs but little from the general type. The only essential constituent of the visual sense-organ is the retina, which forms so small a part of the eyes of the higher animals; and the simplest eyes are nothing but portions of the integument, in which the cells of the epidermis have become converted into glassy, rod-like retinal corpuscles. The outer ends of these are turned toward the light; their sides are more or less extensively coated with a dark pigment, and their inner ends are connected with the transmissive nerve-fibers. The light impinging on these visual rods produces a change in them which is communicated to the nerve-fibers, and, being transmitted to the sensorium, gives rise to the sensation—if indeed all animals which possess eyes are endowed with what we understand as sensation.

In the higher animals, a complicated apparatus of lenses, arranged on the principle of a camera obscura, serves at once to concentrate and to individualize the pencils of light proceeding from external bodies. But the essential part of the organ of vision is still a layer of cells which have the form of rods with truncated or conical ends. By what seems a strange anomaly, however, the glassy ends of these

are turned not toward, but away from, the light; and the latter has to traverse the layer of nervous tissues with which their outer ends are connected, before it can affect them. Moreover, the rods and cones of the vertebrate retina are so deeply seated, and in many respects so peculiar in character, that it appears impossible, at first sight, that they can have anything to do with that epidermis of which gustatory and tactile, and at any rate the lower forms of auditory and visual, organs are obvious modifications.

Whatever be the apparent diversities among the sensiferous apparatuses, however, they share certain common characters. Each consists of a receptive, a transmissive, and a sensificatory portion. The essential part of the first is an epithelium, of the second, nerve-fibers, of the third, a part of the brain; the sensation is always the consequence of the mode of motion excited in the receptive, and sent along the transmissive, to the sensorial part of the sensiferous apparatus. And, in all the senses, there is no likeness whatever between the object of sense, which is matter in motion, and the sensation, which is an immaterial phenomenon.

On the hypothesis which appears to me to be the most convenient, sensation is a product of the sensiferous apparatus caused by certain modes of motion which are set up in it by impulses from without. The sensiferous apparatuses are, as it were, factories, all of which at the one end receive raw materials of a similar kind—namely, modes of motion—while at the other each turns out a special product, the feeling which constitutes the kind of sensation characteristic of it.

Or, to make use of a closer comparison, each sensiferous apparatus is comparable to a musical box wound up, with as many tunes as there are separate sensations. The object of a simple sensation is the agent which presses down the stop of one of these tunes, and the more feeble the agent, the more delicate must be the mobility of the stop.*

But, if this be the case, if the recipient part of the sensiferous apparatus is in all cases merely a mechanism affected by coarser or finer kinds of material motion, we might expect to find that all sense-organs are fundamentally alike, and result from the modification of the same morphological elements. And this is exactly what does result from all recent histological and embryological investigations.

It has been seen that the receptive part of the olfactory apparatus is a slightly modified epithelium, which lines an olfactory chamber deeply seated between the orbits in adult human beings. But, if we trace back the nasal chambers to their origin in the embryo, we find that, to begin with, they are mere depressions of the skin of the fore-part of the head, lined by a continuation of the general epidermis. These depressions become pits, and the pits, by the growth of the adjacent parts, gradually acquire the position which they finally occupy.

* "Chaque fibre est une espèce de touche ou de marteau destiné à rendre un certain ton."—Bonnet, "Essai de Psychologie," chap. iv.

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The olfactory organ, therefore, is a specially modified part of the general integument.

The human ear would seem to present greater difficulties. For the essential part of the sense-organ, in this case, is the membranous labyrinth, a bag of complicated form, which lies buried in the depths of the floor of the skull, and is surrounded by dense and solid bone. Here, however, recourse to the study of development readily unravels the mystery. Shortly after the time when the olfactory organ appears as a depression of the skin on the side of the fore-part of the head, the auditory organ appears as a similar depression on the side of its back part. The depression, rapidly deepening, becomes a small pouch, and then, the communication with the exterior becoming shut off, the pouch is converted into a closed bag, the epithelial lining of which is a part of the general epidermis segregated from the rest. The adjacent tissues, changing first into cartilage and then into bone, inclose the auditory sac in a strong case, in which it undergoes its further metamorphoses; while the drum, the ear-bones, and the external ear are superadded by no less extraordinary modifications of the adjacent parts. Still more marvelous is the history of the development of the organ of vision. In the place of the eye, as in that of the nose and that of the ear, the young embryo presents a depression of the general integument; but, in man and the higher animals, this does not give rise to the proper sensory organ, but only to part of the accessory structures concerned in vision. In fact, this depression, deepening and becoming converted into a shut sac, produces only the cornea, the aqueous humor, and the crystalline lens of the perfect eye.

The retina is added to this by the outgrowth of the wall of a portion of the brain into a sort of bag or sac with a narrow neck, the convex bottom of which is turned outward or toward the crystalline lens. As the development of the eye proceeds, the convex bottom of the bag becomes pushed in, so that it gradually obliterates the cavity of the sac, the previously convex wall of which becomes deeply concave. The sac of the brain is now like a double nightcap ready for the head, but the place which the head would occupy is taken by the vitreous humor, while the layer of nightcap next it becomes the retina. The cells of this layer which lie farthest from the vitreous humor, or, in other words, bound the original cavity of the sac, are metamorphosed into the rods and cones. Suppose now that the sac of the brain could be brought back to its original form; then the rods and cones would form part of the lining of a side pouch of the brain. But one of the most wonderful revelations of embryology is the proof of the fact that the brain itself is, at its first beginning, merely an infolding of the epidermic layer of the general integument. Hence it follows that the rods and cones of the vertebrate eye are modified epidermic cells, as much as the crystalline cones of the insect or crustacean eye are; and that the inversion of the position of the former in relation to light arises

simply from the roundabout way in which the vertebrate retina is developed.

Thus all the higher sense-organs start from one foundation, and the receptive epithelium of the eye, or of the ear, is as much modified epidermis as is that of the nose. The structural unity of the sense-organs is the morphological parallel to their identity of physiological function, which, as we have seen, is to be impressed by certain modes of motion; and they are fine or coarse in proportion to the delicacy or the strength of the impulses by which they are to be affected.

In ultimate analysis, then, it appears that a sensation is the equivalent in terms of consciousness for a mode of motion of the matter of the sensorium. But, if inquiry is pushed a stage further, and the question is asked, What then do we know about matter and motion? there is but one reply possible. All that we know about motion is that it is a name for certain changes in the relations of our visual, tactile, and muscular sensations; and all that we know about matter is that it is the hypothetical substance of physical phenomena—the assumption of the existence of which is as pure a piece of metaphysical speculation as that of the substance of mind.

Our sensations, our pleasures, our pains, and the relations of these make up the sum total of the elements of positive, unquestionable knowledge. We call a large section of these sensations and their relations matter and motion; the rest we term mind and thinking; and experience shows that there is a certain constant order of succession between some of the former and some of the latter.

This is all that just metaphysical criticism leaves of the idols set up by the spurious metaphysics of vulgar common sense. It is consistent either with pure Materialism, or with pure Idealism, but it is neither. For the Idealist, not content with declaring the truth that our knowledge is limited to facts of consciousness, affirms the wholly unprovable proposition that nothing exists beyond these and the substance of mind. And, on the other hand, the Materialist, holding by the truth that, for anything that appears to the contrary, material phenomena are the causes of mental phenomena, asserts his unprovable dogma, that material phenomena and the substance of matter are the sole primary existences.

Strike out the propositions about which neither controversialist does or can know anything, and there is nothing left for them to quarrel about. Make a desert of the Unknowable, and the divine Astræa of philosophic peace will commence her blessed reign.—*Nineteenth Century.*

RESIDUAL PHENOMENA.

By Professor PATTISON MUIR.

IN his "Preliminary Discourse on the Study of Natural Philosophy," Sir John Herschel remarks upon the importance of examining those phenomena of nature which are not wholly explicable in terms of any well-established theory. Instances of such residual phenomena, as Sir John Herschel terms them, are given in the discourse.

Newton's theory of comets, viz., that these bodies obey the law of gravitation while revolving in oblique orbits round the sun, appeared to account for the facts which had been noticed concerning the comet of Halley; but the period calculated for Encke's comet, on this hypothesis, was found to be rather longer than the actual, observed period, and, moreover, the duration of the observed period showed a small but regular diminution. Hence, Newton's theory, taken alone, was not sufficient to account for the facts. But, inasmuch as Newton's law of gravitation rested upon a sure and well-established foundation, the fact observed concerning Encke's comet could not be regarded as disproving the law; hence these facts were to be explained by tracing them to the action of some agent either of known or of, as yet, unknown nature.

The regularly diminishing period of Encke's comet remained a residual phenomenon, not contradicting the law of gravitation, but awaiting full explanation.

A residual phenomenon is, then, a phenomenon which is not fully explained by any established theory; but at the same time it is not a phenomenon which is absolutely contradictory to any such theory, for, if this were the case, the theory in question must perforce be abandoned.

Advances are made in natural science by a judicious use of hypotheses. Facts are accurately observed, or are gained by exact experiment, and are compared with facts; inferences are drawn, and are compared with other inferences, until a good working hypothesis is attained. From this hypothesis deductions are made which must necessarily prove true if the hypothesis be correct; the truth or falsity of the alleged facts is tested by an appeal to Nature; and so wider hypotheses are gained, each in turn being tested and tried by an appeal to facts, until, finally, that generalization is reached which includes in its expression so many and so varied phenomena that to it is given the name of a "law of Nature."

But notwithstanding the sure and tried foundations upon which each law of nature rests, phenomena ever and anon become apparent which refuse to be completely explained by any of these laws. Upon more careful examination, it may be found that such phenomena have been erroneously observed, and they may be brought under the application

of a known law, acting perhaps in a peculiar and even unprecedented manner. In such cases the phenomena cease to be residual phenomena.

But, on the other hand, some of the observed phenomena may resist every attempt made to explain them; they may refuse to retire from the list of established facts, and at the same time refuse to find their full explanation in terms of any well-established law. But, while so doing, these phenomena may also not be opposed to the law; they may not be contradictory to, but simply not wholly explainable by, any known law of nature.

Instances of the valuable results which have been obtained by the exact investigation of residual phenomena are numerous in every branch of natural science. One of the most striking is furnished by Newton's investigation of the atmospheric velocity of sound.

Newton showed that the velocity of sound in air might be calculated from certain theoretical considerations; a rough measurement of the actual velocity gave him a number differing very considerably from that which his theory required. Later and more exact experiments failed to explain the discrepancy, but in 1816 Laplace gave an explanation of the seemingly exceptional phenomenon, which not only sustained the theory of Newton, but also paved the way to the modern doctrine of the equivalency of heat and mechanical work. In the residual phenomenon which was left unexplained by Newton lay the germ of one of the greatest advances made by science in recent years.

Another striking instance of the value of residual phenomena is to be found in the history of chemical science.

From his experiments upon combustion, Lavoisier concluded that the peculiar properties of acids are due to the presence of the element oxygen in these bodies. But an undoubtedly acid substance was known (muriatic acid) from which no oxygen could be obtained. Here was a residual phenomenon—a phenomenon not absolutely contradictory of the law, that that group of bodies called acids is characterized by the presence of oxygen, but certainly a phenomenon demanding accurate investigation. Closer examination might have shown that the acid supposed to contain no oxygen was not really free from that element, or it might have led to the adoption of a higher generalization concerning the nature of the group "acids," or, lastly, it might have necessitated an entire alteration in the terms of Lavoisier's so-called law.

Chemists, however, for many years contented themselves with asserting that, as Lavoisier had pronounced oxygen to be the acidifying principle, and as muriatic acid was undoubtedly a true acid, this body *must* contain oxygen. But Sir Humphry Davy showed that an accurate examination of the residual phenomenon presented by muriatic acid led to a more extended and more exact knowledge of the nature of acids, and necessitated a change in the prevalent views concerning these bodies. The views of Lavoisier were found to express a truth, but not the whole truth; fresh incitement was given to research, and

fresh advances were quickly made in the knowledge of groups of compound bodies.

But there is another way in which the investigation of residual phenomena may aid, and has largely aided, the advance of scientific knowledge.

Phenomena, regarded as residual, have not unfrequently been shown to be completely explicable in terms of a known law; and thus fresh light has been thrown upon the modifying influence exerted on the action of the law by the conditions under which the law acts.

The orbit of Lexell's comet was accurately determined; nevertheless, the comet failed to appear at the proper time. Here, surely, was a phenomenon which could not be explained by the law of gravitation alone: hypotheses, plausible and probable in themselves, were broached to account for the apparently exceptional phenomenon. But subsequent investigation showed that that appearance of the comet, from observations of which the orbit had been calculated, was due to the disturbing influence of one of the members of the solar system (probably of Jupiter) whereby the comet had been dragged within the limits of our vision, but that this visit to earthly spheres was altogether abnormal: the phenomenon presented by the visit of the comet was entirely explicable in terms of the law of gravitation.

What could be more opposed to our ordinary notions concerning the effects of heat than the fact that water should be frozen in a red-hot vessel? But this phenomenon, apparently inexplicable in terms of any known law, upon exact investigation finds demonstrable explanation without recourse being had to the action of an unknown agent. The experiment is carried out by pouring liquid sulphur dioxide—a liquid which boils at a temperature lower than that of the freezing-point of water—into a red-hot platinum crucible, immediately adding a little water, and quickly turning out the ice which is produced.

Experiment shows that when a liquid is suddenly brought into contact with a highly heated smooth surface, vapor is evolved which surrounds the mass of liquid as it were with a screen through which the heat, radiated from the hot surface underneath, passes but slowly; the liquid thus rests upon a cushion of its own vapor, and does not touch the hot surface beneath. The temperature of a mass of liquid in this (*spheroidal*) condition is lower than that at which the liquid boils. Now, as liquid sulphur dioxide boils at a temperature lower than that at which water freezes, and as immediately the liquid touches the heated platinum crucible it is partially vaporized, and the residual liquid is then floated, so to speak, upon the stratum of gas so produced, it follows that, so long as this condition is maintained, the liquid contents of the crucible are at a very low temperature; hence the temperature of the water coming into contact with this cold liquid is greatly reduced, and the water is frozen.

Exact investigation of this phenomenon, therefore, adds much to

our knowledge of the laws which govern the vaporization of liquids, and shows us these laws at work under peculiar conditions, while at the same time it brings the apparently exceptional phenomenon under the domain of a known law. Once more, the examination of residual phenomena may be, and has often been, of immense service to science, in freeing naturalists from the tyranny of an established theory which has for long been regarded as of necessity affording a full explanation of the entire series of facts to which it is applied.

The tyranny of orthodoxy is not unknown in science. The overthrow of that tyranny is one result of the investigation of residual phenomena.

During the greater part of the eighteenth century the theory of Phlogiston was all-prevalent in chemistry. According to this theory, when a body burns, it gives out a something called *Phlogiston*, the escape of this mystical something being the cause of the phenomena which attend the combustion.

This theory accounted in a fairly satisfactory manner for the greater number of the observed facts. One little fact, however, was scarcely explicable by the Phlogistic theory. So far as rough measurement went, the weight of the burned body appeared to be greater than that of the body previous to combustion. This residual fact was long overlooked, but the genius of Lavoisier forbade him to pass over so important a circumstance. By repeated and exact experiment, Lavoisier established the correctness of the residual phenomenon, and he showed that the phenomenon was inexplicable in terms of the commonly accepted theory.

Modern research has taught us that the fact firmly established by Lavoisier is not absolutely contradictory of a modified Phlogistic theory; but Lavoisier's work necessitated a thorough revisal of the prevalent theory of combustion, and prepared the way for great advances which have at last enabled us to reconcile his theory with that of the Phlogisteans in modified form. Had Lavoisier consented to overlook the seemingly little fact that a body after burning is heavier than it was before, chemical science would probably have been for many years compelled to submit to the thralldom of the Phlogistic theory, which, in its then accepted form, barred the path of true advance.

When Galileo's telescope discovered to the gaze of the astronomer the satellites of Jupiter, did not those in authority protest most vehemently against the residual phenomenon? Why? Because they saw that this phenomenon could not be made to fit into the accepted cosmical theories of the day: not only was it inexplicable in terms of these theories, but it was absolutely opposed to them. Galileo, however, persisted, the phenomenon was more fully investigated, and the science of astronomy was placed upon a sure basis; the reign of mere authority in scientific matters was brought to an end, and Nature was installed as the supreme adjudicator in all matters of scientific inquiry.

But the examination of residual phenomena may also help to free investigators from that tyranny which is exerted by a number of concordant results, all seemingly pointing to but one conclusion.

If experiment after experiment points to one conclusion, and if all, with the exception of perhaps a single residual fact, is in favor of this conclusion, it is hard to resist the temptation to ignore that fact, and adopt what, but for it, is apparently the true conclusion. But this method is not the scientific method. The fact must be examined. It may be that the outstanding fact is finally reduced within the sphere of the previously adopted hypothesis, or it may be that a new hypothesis is suggested which explains this and all the other phenomena.

The great Swedish chemist Berzelius carefully examined the properties of the compounds of a newly discovered element; he determined the chemical and physical characteristics of this element, to which he gave the name of Vanadium. The facts ascertained by the experiments of Berzelius formed a concordant series; so far as these experiments extended, everything appeared to be in keeping with the conclusions arrived at by him. But it was afterward noticed that the crystalline form of certain compounds of the metal vanadium was different from that required by the commonly accepted and, as it appeared, well-established theories concerning the connection between crystalline form and chemical structure. The examination, by Roscoe, of the residual phenomena presented by the crystalline forms of the vanadium compounds led to the astonishing discovery that the so-called metallic vanadium of Berzelius was really not an elementary body, but a compound of the true metal vanadium with oxygen. This peculiar oxide presents most of the physical properties of a metal; indeed, so metal-like is this oxide that the presence in it of oxygen was entirely overlooked, even by so careful a worker as Berzelius.

The researches of Roscoe threw a new light upon the chemical history of vanadium, and at the same time confirmed in a marked manner the law connecting chemical structure with crystalline form.

But, lastly, the study of residual phenomena may aid in freeing our minds from that fascinating, but surely erroneous, idea which a mere superficial acquaintance with natural science tends so much to strengthen, viz., that Nature is, and indeed must be, extremely simple.

The simplicity of Nature is a favorite theme with a certain class of would-be philosophers: it is a doctrine easily accepted, but a doctrine which has led to pernicious results.

Extreme instances of the overruling power of this idea may be found in the fascination exerted over minds, even of the highest order, by numerical analogies, that are really baseless. The seven colors of the spectrum were supposed, even by the great master himself, to have some mysterious connection with the seven tones of music. The number of the satellites of Jupiter added to the single satellite of the earth leaves but one satellite for Saturn, if the perfect number six is to be

made up; hence Huygens concluded that Saturn could have but one satellite.

When chemistry emerged as a distinct branch of science from the superstitions and conceits which had so long overshadowed her, the line of demarkation between chemical and mechanical action was made clear and unmistakable. On this side were ranged all phenomena purely mechanical; on that, all phenomena purely chemical. Nature's laws *must* be simple. One great fact was predicated of each class of phenomena—the distinction was a simple distinction. But as Nature's facts were more thoroughly searched into, phenomena were remarked which tended to discredit the extreme simplicity of the division into chemical and mechanical actions; those phenomena were passed by as too trivial for serious notice. But the residual phenomena at last forced themselves upon the attention of chemists; and one great result of the examination of these phenomena has been the discovery that the simple classification into chemical phenomena on that side and mechanical on this was too simple—was, in fact, an artificial classification; that there is no sharp line of demarkation in Nature, but that a series of facts exists which bridges over the gulf formerly supposed to be fixed between the two sets of phenomena.

The earlier study of biological science tended to show a great simplicity in the vital processes occurring among all living things; but the more advanced study of the same science has altogether overthrown the simplicity of the earlier scheme. Certain animals, and classes of animals, seem deliberately to adopt strange expedients for reproducing their kind, as if to warn us against such hasty generalizations. How should we have imagined the possibility of fertilization for successive generations, of hermaphroditism, or of reproduction by fissure, etc., being found among the methods which Nature adopts for replenishing the earth, had we contented ourselves with an examination of the comparatively simple methods of ordinary sexual reproduction?

The importance of residual phenomena is undoubtedly great; the difficulties which attend the study of these phenomena are likewise great.

A phenomenon, supposed to be residual, may be found on closer examination to be fully explained by some known law, acting either under ordinary or under modified conditions. Before, therefore, attempting to find a new hypothesis which shall explain the residual phenomenon, it is necessary to determine the fact of the phenomenon being truly residual. Of course, if an explanation be found for the seemingly inexplicable phenomenon without the necessity of introducing a new hypothesis, a distinct step has been made in scientific advance. If, however, the phenomenon refuse to be explained by any known law, a new hypothesis must be found, or the old must be modified so as to admit of an explanation being given for the hitherto inexplicable fact.

Of the new hypotheses which present themselves to the mind, which

shall be chosen? That which is clear and definite, and from which results can be deduced in a form which permits of their being tested by experiment.

If such an hypothesis be found, it then becomes necessary to ask, Does this hypothesis explain facts other than those included in the special residual phenomenon under consideration? An hypothesis which explains, or seems to explain, an isolated phenomenon, but which does not include other phenomena within its grasp, or which does not leap to the discovery of hitherto unknown facts, may be a true hypothesis, but it is certainly one which must be accepted with caution, and only provisionally until a better be found.

Finally, the new hypothesis must be in keeping with the well-established laws of nature. An hypothesis which contradicts any of these can not be accepted, although it may explain the special phenomenon to give a reason for which it has been called into existence.

The recent history of natural science furnishes many examples of the use of residual phenomena. Let me mention two only: one, in which an hypothesis has been suggested, proved, and adopted; another, in which the value of the hypothesis suggested is not yet finally determined.

It is well known that plants derive their support from the air and the soil; that support consists partly of mineral, partly of vegetable matter. But the curious fact was noticed that the leaves of certain plants frequently had adhering to them remains of insects or even entire insects. Following up this fact, Mr. Darwin and others have established the generalization that members of more than one species of plants derive their nourishment mainly from animal matter, and that these plants thrive better upon such food than upon the ordinary kinds of plant-food. Thus another thread has been added to the bond which visibly connects the animal and vegetable kingdoms.

The chemical elements have long been regarded as truly elementary bodies, that is, as bodies from which no form of matter other than themselves can be obtained. But phenomena presented by the spectra of certain of these elements seem almost inexplicable by the commonly accepted view. Mr. Lockyer has carefully examined many of the so-called elementary spectra, at temperatures varying from that of a gas-flame to that of the star Sirius, and, in order to explain the phenomena noticed, he has provisionally adopted the hypothesis that the so-called elements are really compound bodies. This hypothesis, whether eventually confirmed or refuted, suggests a large field for research to the chemist and to the physicist, from which neither can fail to reap most valuable results.

The observed residual phenomena of nature which yet await solution are many and varied; every branch of scientific work presents its own list. Let me glance at a few, and they shall be chiefly chosen from those phenomena which are investigated by the science of chemistry.

That the molecules of the elements, i. e., the smallest individual parts which exhibit the properties of the elements, consist of yet smaller parts, or atoms, is undoubted. The generalization holds, with few exceptions, that the elementary molecules contain each two atoms. The exceptions are exhibited by the elements phosphorus, arsenic, cadmium, and mercury, the two former being possessed of molecular weights four times as great as their atomic weights, while the molecular weights of the two latter are equal to their atomic weights. No conclusive explanation has as yet been given of this fact; it remains a true residual phenomenon.

Again, the atoms of the elements are possessed each of a certain definite binding power. Each is capable of uniting with a fixed maximum number of other atoms, but this binding power is not always completely exercised. Why does this power vary? How is its action modified by the conditions under which it is exercised? Can the known facts concerning the action of this binding power, or valency as it is called, be brought within the scope of any definite and workable hypothesis? These questions are to be solved by the researches of the chemists of the future.

Once more, the properties of certain elements vary considerably with variations in the conditions of those elements. Oxygen, when exposed to the action of the electric discharge, is not split up into any form of matter other than itself, nor does it combine with any other form of matter, nevertheless its properties are largely modified. The molecular weight of ozone—the new form of oxygen produced by the action of the electric discharge—is known to be one and a half time greater than that of ordinary oxygen. But, nevertheless, no complete explanation of the facts, of which this special fact is a representative, has yet been given. Allotropy remains a residual phenomenon in chemical science.

Many animal instincts, e. g., the curious instinct which prompts the cuckoo to lay a single egg in a nest not her own, connected as this instinct undoubtedly is with the similar but less perfectly developed instinct of the American *Molothrus bonariensis*, have not as yet been completely brought within the sphere of any wide generalization.

Why should the use of its sting inflict injury, if not death, upon the bee?

Why do variations in structure or function arise suddenly in various animals?

These questions, and many questions similar to these, await their full explanation.

Science advances by slow but sure steps; she carefully propounds hypotheses, and carefully marks off those phenomena which these hypotheses leave unexplained. She is aware that the phenomena occurring in that immense sphere assigned to her are not always to be explained by one, but often by many hypotheses. Phenomenon is

modified by phenomenon. Law reacts upon law. All she knows is lawful, but all is not yet intelligible. With patience and sure faith she advances to the goal; the road is long, but the reward is great.—*Fraser's Magazine.*

THE "AUTOBIOGRAPHY" OF GEORGE COMBE.*

By ELIZA A. YOUMANS.

GEORGE COMBE has been dead twenty years, and his name is almost forgotten. Many of his teachings, which were bitterly opposed when he uttered them, are now quietly accepted. His theories of religion, of education, of the treatment of the insane and criminal classes, are more or less approved, and even the doctrine that mind is a function of the brain, which he was among the first to assert, and for which he was denounced as an infidel, has taken its place among the data of science. But the system of phrenology to which he gave himself with such intense devotion is discredited by science, and, like Mr. Combe himself, is now seldom heard of. There is much, however, in his biography to interest those who remember him, and who sympathized with his career as a reformer. But it is not to the biography at large that we now call attention, but to a fragment of autobiography which occupies the opening pages of the book, and embraces the period of his childhood and early youth. For, although he was born in another country (Scotland), and a former century (1788), yet the essential experiences of the home, the play-ground, and the school, were the same there that they are here, and the same then as now. Combe understood the conditions of well-being for both mind and body, and the far-reaching consequences of conduct. He had made his "bringing up" a matter of serious study, and he wrote this sketch, as he spent his life, for the good of others. We have found it by far the most interesting portion of a very ably-written biography. But, since we can not print the whole of it, we give that portion which treats of his education, with such explanations as are needed to make it intelligible.

For the benefit of our youthful readers, it may be well to state that from 1817 to 1836, while still practicing the legal profession, Mr. Combe kept up a fierce warfare in defense of phrenology and certain principles of right living, which he published in a work entitled "The Constitution of Man." This book had an immense circulation, and was translated into the leading languages of Europe. In 1837 he retired from his profession and gave the rest of his life to the dissemination of his principles. He traveled in England, America, and Germany, and

* The Life of George Combe, author of "The Constitution of Man." By Charles Gibbon. In two vols. London: Macmillan & Co., 1878. Price, $8.00.

lectured on phrenology, education, physiology, the laws of health, and the sources of the well-being of nations. He was a leader in the struggle for what he called secular education—that is, a training in such knowledge as applies to the duties of life—he advocated prison reform, and in 1857, the year before his death, he published a work "On Religion and Science," the product of much anxious labor and the "outcome of his life's thought."

Dr. Andrew Combe, brother of George Combe, and nine years his junior, was also a man of remarkable ability and force of character, and both the brothers had feeble constitutions, suffering all their lives from ill health. They agreed in the belief that their infirmities were brought upon them by the circumstances of their childhood. Andrew died in 1847, and his "Life" was written by his brother George, who made a point of exposing the unhealthful conditions to which his brother had been subjected in early life. But some of the relatives were unwilling that these family details should be published to the world, and so they were omitted from the biography. But, when George Combe afterward wrote a full account of the first sixteen years of his own life, the suppressed portion of his brother's biography was embodied in it, and this is the autobiography with which we are now concerned. It was natural, perhaps, that relatives should object to its publication; but certainly in no other part of the work before us are Combe's tenderness, sense of justice, and ability, better shown than here; for, while he tells everything frankly, he all the while impresses the reader with the upright, affectionate, and intelligent character of his parents.

We condense from Combe's account the following significant details: At the time of his birth his father was forty-two and his mother thirty years old. She was short, well-formed, quiet, energetic, decided, and sensible. She was accomplished in every practical art of housekeeping. She could milk, churn, make butter, wash, cook, spin, shape and sew clothes for both sexes; was active and methodic, and generally had her work done before dinner, and was ready to pay and receive social visits. She could read and could write her name, which was a fair literary education in those times. The father was six feet two inches in height, strong in trunk and limbs, with a large head, and perfect health. He wrote exellent sense and good composition, but was imperfect in grammar and spelling. He was painfully aware of these defects, and used to say he would rather hold the plow for a day than write a letter of a page in length. His over-consciousness in this matter "led him to educate his sons to the best of his ability and his lights." They had seventeen children. George was a well-formed, healthy child, and so far as character depends upon inheritance he had nothing to complain of.

The house where they lived stood close under the southwest bank and rock of the Castle of Edinburgh. The locality was low, and, while the windows looked upon gardens and corn-fields, the ground behind

was a filthy swamp in winter, and covered with dunghills in summer; tan-works and magnesia-works poured their refuse into open ditches of small declivity all around the place. The public drain from two humble localities of Edinburgh ran uncovered past the dwelling, and the house itself was connected with his father's brewery. A more unhealthy residence could hardly be conceived. The two-story house contained two rooms, a kitchen and bedroom on the lower, and three rooms and a very small bedroom on the upper floor. When Combe was about ten years old an additional room and bedroom were built. At about this time (1798) the family consisted of the parents, thirteen children, and the servants, all crowded into these small rooms. Combe says, "The conditions of health and disease were wholly unknown, the mind being regarded as independent of the body, and the constant sickness and many deaths in the family were never thought of in connection with these material surroundings."

Combe thought that if people only knew better they would do better; but after a lapse of eighty years, and with our abundant knowledge of sanitary science, it seems that in the public schools of New York to-day the conditions of health and disease are frequently no more thought of than they were in Edinburgh when Combe was a child.

It will be observed that, in telling us about his education, Combe all the while distinguishes sharply between his *real* education and his *nominal* education. His knowledge of mental science, such as it was, helped him to interpret his own experiences. The things he remembers are to him indexes to his natural gifts, as the strongest impressions would be made on his predominant faculties. By this means he discovers the emotional bias that shaped his life, in the incidents of a summer spent on his uncle's farm when he was three or four years old. His first remembered lesson was given him here by one James Reid, a young farmer who came often to visit his aunt and cousins. Combe says of him:

> He was a clever, intelligent person, and fond of jokes and fun. He gave me a large red field-turnip, hollowed it out, cut a nose, mouth, and eyes in one side, put a candle within, and astonished me by the apparition of a human face with a dark-purple skin. He taught me to give myself a number of ridiculous names, such as Timothy, Peter, Baldy, Elshinder, and so forth; and for the sport which this afforded he gave me a halfpenny. The list was closed with the name "Scoundrel Grant" (the familiar name of a mean man in Edinburgh); and I observed that when I wound up by giving myself this appellation there was a loud shout of laughter from all the company. This hearty laugh led me to suspect something wrong in that name, and I stopped short at it. Mr. Reid tempted me with another halfpenny to complete the list, and I reluctantly uttered "Scoundrel Grant." The reward was given amid shouts of laughter, and for the first time I became conscious of conflicting emotions. I was as much ashamed of the name as I was pleased by the money, and when I was at length told what "Scoundrel Grant" meant no power on earth could induce me to give myself the name.

Another incident of this summer must be noted. He fell into a small rivulet, wet his clothes, and remained out while they dried. He caught a severe cold, and was sent home to die of consumption.

His school education began when he was five or six years old. The schoolroom was small, low in ceiling, and crowded with children. In the course of the summer his strength gave out. He says:

From nine to twelve I could see to read; but in the afternoon, from one to three, the letters were hazy and I could not distinguish them. I told the teacher my condition and was sent home. When I told the family why I left school there was great wonderment. My brother John thought I was shamming. He put pieces of wheaten bread and oat-cake of similar size and appearance before me and asked which was which. I could not tell. He then gave me the aid of my father's spectacles, and I at once named the crumbs correctly. He thought he had now caught me, for he said, "A young person can not see clearly with an old person's spectacles." I protested my truthfulness, and was mortified at being suspected of deceit. But my mother came to the rescue, and said she did not think I was feigning. She took me from school and put me to sea-bathing. In fact, there was nothing anomalous in my seeing with my father's spectacles: he was little past middle life, and they were of low power. I was probably as much debilitated in brain and eye as an aged man, and the spectacles might suit my condition as well as his. But it is difficult for me to describe the grief and indignation which the suspicions of the family roused within me.

He had a pleasant summer by the sea; the ships sailing up and down the Frith of Forth, and the fishing-boats which studded the water for miles were objects of vivid wonderment and interest to him.

His next schooling is thus described:

Mr. Campbell, who kept a school near by, taught me to read and spell after the fashion of those days; i. e., I spelled and pronounced the vowels without once dreaming that the words had a meaning. The idea that English words in a printed book were signs of feeling did not dawn upon me till years afterward. I knew only broad Scotch, and an English book was as unintelligible as a Latin book.

As to his religious education at this period he says:

I went regularly to church, but never understood one word of the sermon. This gave rise to a habit of inattention to spoken as well as written language. Whenever I was out of reach of my father's foot and hand I fell asleep, the refreshment of which was the only advantage of my church-going.

When he was six or seven years old he was again sent to the sea-side, and left with a family of old people who had no sympathy with children. The months he spent there were full of wretchedness. He thus refers to them:

I slept on a "shake-down" in the garret, and the mice careered over me in the night. During the day I wandered in the harbor, but there were no ships in it; climbed the banks above the town, where were only corn-fields; built castles of wet sand and knocked them down again, all alone; and wearily, wearily did day pass away after day, bringing no change. I was a shy boy, or I might have found acquaintances in the street.

He was taken home in September, but such was the effect of the unwholesome position of his father's house, of its overcrowding, and of mistakes in his diet, that he had glandular swellings ending in suppuration. His brain was strong and active, and at school would blaze away for a few days until he was completely exhausted, when he would stay at home and lie on the sofa three or four days till the nervous energy was recruited. (These alternating periods of vivacity and exhaustion continued throughout his life.) He thus records an incident of his childhood, as an example of the influence which a passing observation of a sensible servant may exercise on the mind of an earnest, thoughtful child :

> About this time one of my mother's servants from whom I received sincere sympathy, observing my feeble condition, said, "O laddie, you should never marry." Young as I was, I understood her meaning, and her remark made an indelible impression on me.

The train of thought which, late in life, Combe gave to the world in his essay upon "Religion and Science" was started by an incident of his early childhood. When six or seven years old he was given a lump of candy. The nurse-girl asked him to share it with his brothers and sisters, which he did. The girl then assured him that God would reward him for it. When he asked her "How?" she told him God would send him everything that was good. Should he get more candy? he inquired. Yes the girl told him, if he was a good boy. Would the piece he had left grow bigger? "Yes," was the reply, "God always rewards the kind-hearted." So the remaining piece was carefully wrapped in paper and put in a drawer and left all night. The next morning he examined it with eager curiosity, but no change could be discovered in it, and he had the bitterness to find that he had been benevolent at his own expense. His faith in the reward of virtue received a shock, and it was a long time before he learned the true nature of Divine rewards for good deeds.

While still a child, he saw a man and woman walking near the verge of the highest part of Salisbury Crags. Soon an alarm was given that the man had pushed the woman over the precipice and she was killed. The man fled down the northeast slope of the hill and never was discovered. Combe says his imagination was haunted by the recollection of this scene; and he was terrified to go to sleep lest he should see the murdered woman's ghost. The belief in ghosts was universal in his juvenile circle, and a sore superstition it was, for he held "every belief to be as true as the most indubitable facts." Another striking event of his early boyhood awakened in him a sense of the mistakes of Government. Two sons of a poor widow, whom his father had helped, poured forth their gratitude in every form of kindness to his father's children. One of them had been to Greenland in a whale-ship and he delighted young George with accounts of the perils and excitements of whale-fishing. Paid spies of the press-gang gave in-

formation of his liability and his residence, and he was torn from home and friends and forced aboard a man-of-war. Combe says:

> It is impossible to describe the horror and indignation with which this event filled me. It gave the first rude shock to my feelings of respect toward the ruling powers. I had worshiped the King and looked upon the Lord-Provost with reverence and awe. But this incident converted me from a loyal, trusting, Tory child, into a demagogue and reformer.

One day as he was walking along the road with one of his father's workmen they met a tall man, in Highland costume, with a huge cap and plumes, and a fearful-looking iron-hilted sword, who asked the workman, "Is this your son?" "No," said the man. "Is he a good boy?" "Yes, he behaves very well," said the man. "I am glad of it," said the soldier, laying his hand on his sword, "for it is my duty to cut off the heads of all naughty children." Combe says, "I believed every word of this assurance and for months dared not venture into the street without keeping an anxious watch for this sergeant who had filled me with unutterable horror."

These incidents may seem trivial, but they formed the staple of his practical education. He says that "great drifts of suffering were driven through the tenor of my life by the absence of consistent principle in the actions and teaching of all by whom I was surrounded." And it was the vivid recollection of this unhappiness which determined his career as a reformer.

At the age of nine he entered the High School of Edinburgh, where he staid four years. There were about one hundred boys in his class, and the learning was mere memorizing. The teacher, Mr. Fraser, every afternoon gave out lessons (Latin) to be learned for the next day. In the morning he began at the head of the class and heard each scholar repeat the portion of grammar he had learned by heart. Next came translation. The sons of rich parents had tutors, of evenings, who *taught* them, but Mr. Fraser *taught* nothing. These boys were at the head of the class, and with them the lessons went on smoothly; but, when the incapables were reached, "beating took the place of teaching." By standing from twenty-five to forty-five from the head of the class young Combe learned his lesson by hearing those above him read it, and in this way escaped beating, except when the teacher was disturbed by a noise; then, says Combe—

> He held us all bound for each other's transgressions, and let loose upon us a perfect storm of lashes, and never ceased till he was fairly out of breath.
>
> The discipline waxed severer as time passed on, and in the third year it reached its acme. In the spring of that year Mr. Fraser "stripped and whipped," to use his own expression, the boys at a great rate. I recollect one *day* seeing fifteen boys standing at a time in the middle of the floor with their breeches stripped down, and he taking hold now of one and now of another, threatening to commence the "whipping." These inflictions were uniformly accompanied by a phraseology in utter contrast to their real character. When he called on a boy

to hold out his hand to receive a shower of palmies, it was—"Here, if you please, my dear." Whack, whack, whack; scream, scream, scream. "It is all for the good of your soul and your body, my dear." In the third year all this discipline appeared to him insufficient; and, after announcing, "I must try a severer rod of correction, my dears," he walked to a small closet in the school, opened it amid portentous silence, and brought out a short riding-whip, such as game-keepers are armed with, and with which in those days they lashed the hounds. It had a lash of knotted cord, and a short, thick handle, with an ivory whistle at the end; and with this "rod of correction" he commenced operations. The lash twisted around the hand, leaving red scores on the skin, and, where the knots struck, in some instances drawing blood.

All this torture was a substitute for teaching. There was not a map or illustrative object of any kind in the schoolroom; and only on two occasions during the four years did he ever, to my recollection, address a word to us beyond translation and grammar of the baldest description. The first of these exceptions took place when we read the description of the bridge erected by Julius Cæsar over the Rhine, given in his "Commentaries." Our teacher had, according to tradition, constructed a model of the bridge with his own hands, and was proud of it. The fame of its great interest had been transmitted from class to class for many years; and we counted the days which should bring us to "the brig." At last the closet was opened in profound silence, and the model brought out.

It was placed on a chair in the middle of the floor, and we began to read the description. As there were many technical terms, he helped us by explaining them, and with conscious pride pointed out each stake and beam as we proceeded, and showed us its connections and uses. The reading and expounding lasted for several days, during which all the lessons were better learned than usual, complete silence reigned, and not a blow was struck. We thought ourselves in paradise. But the model was removed, monotony recommenced, and the arm and "the tawse" were again employed to do the work of the teacher's brain.

The noise and inattention which provoked the teacher and led to much of this severity were the natural consequences of our condition. Fully half of the seats stood apart from the wall, and had no backs. In summer we sat on them from 7 to 9 A. M., from 10 to 12, noon, and from 1 to 3 P. M.; and in winter, from 9 to 11 A. M., and 12 to 2 P. M., without any intellectual occupation, except hearing the lessons repeated over and over again as they descended from the top to the bottom of the class. There was suffering from an uneasy position of the body, and nearly absolute vacuity of mind; and this at an age when every fiber of the brain and muscles was glowing with nervous activity. If physiology and the laws of mental action had been known in those days, everything might have been different. The silence, pleasing excitement, and general good behavior which reigned when we had an intelligible object presented to us, clearly indicated what was wanted to render us all happy; but the hint was not taken. In point of fact, there was no other rational knowledge adapted to the young mind in our teacher's brain: *ex nihilo nihil fit** was exemplified in his whole teaching; for the other instance of attention alluded to was due to the occurrence of a thunderstorm, which frightened us by its darkness and proximity. This led him to describe a previous storm of the same kind, which had ended by a thunderbolt striking the front of the Royal Infirmary, quite near to the High School of those days, and breaking the windows on that side. He gave

* From nothing, nothing comes.

us some account of the nature of a thunderstorm, and how after a terrible crash the danger is past; and thus sustained our courage till the clouds cleared away. No other items of general information, except these two, dwell in my memory as having been communicated during the four years of my attendance.

In 1798 or 1799 I was sent to Mr. Swanston's school, to learn writing and arithmetic. In winter I was in his school, and Mr. Fraser's from eight in the morning till 2 P. M., without any interval of repose; and in summer from 7 A. M. till 4 and often till 6 P. M., with only one hour, from 9 to 10 A. M., for breakfast. Add to this labor lessons to prepare in the evenings, a constant feeling of inanition, especially during winter, cold feet and thin clothing, with no object in the world in my lessons to interest me, and it may well be conceived how the state of sin and misery brought on man by the fall was to me a palpable, undeniable, experienced reality. A few explanations will throw light on the causes of these sufferings. Too much cerebral action, and a close, ill-aired bedroom, with three besides myself in it, made me in the morning low, listless, irritable, and without appetite. My mother had been taught that oatmeal-porridge and buttermilk were the best food for children for breakfast. The buttermilk was bought in large quantities from dairymen's carts in the street. Frequently it was not fresh when bought, and it daily became more acid when kept. To my delicate stomach it often tasted like vinegar, and I revolted at the porridge. In my mother's eyes this was fastidious delicacy of taste, and she ordered the porridge to be kept for my dinner. I received a penny to buy a roll for my mid-day sustenance. At that time the quartern loaf ranged from a shilling to twenty pence in price, and the penny roll was a small morsel for a young, hungry, growing boy. On going out, however, I bought the roll at the first shop—there was one close by my father's gate. I ate it dry, and had no more food till half-past two, when I came home to dinner. My mother was not so severe as she had threatened to be, for she gave me a dinner that I could eat; but she never failed to have the porridge served in the morning. In all this she was actuated by a sense of duty alone, for she was ever aiming at our welfare. Ignorance was the rock on which her kindest endeavors were wrecked, and she was not to be blamed for not knowing what nobody else in her rank, or, so far as I have yet discovered, in any other rank of life, then knew. The cold feet and thin clothing were the consequence of my own self-willed ignorance. She pressed flannel underclothing on me, but because it irritated my excessively sensitive skin I rejected it, and pleaded that it was good for me to learn to be hardy in my youth, to prepare for the trials and exposures of manhood: this was listened to, and the flannel was not forced on me. In the school, and in the West Church especially, in which in those days there were no stoves, I often sat chilled like an icicle, and my only surprise is how I survived so much irrational treatment and stupid conduct.

My constitution, which must have been originally strong, suffered permanent deterioration from all these injurious influences. The bones were imperfectly developed; and bent clavicles and a slight distortion of the spine, with chronic irritability of the mucous membrane of the lungs, were the consequences. The benches of the High School had no backs, but some of them stood close to the walls. I suffered greatly from inability to sit upright, during the long hours of confinement, on the seats away from the wall; and have no doubt that then and there the distortion of the spine was produced. I often abstained from getting up to the third "form" because the fourth stood next the wall and supported my back!

But his out-of-school education all this time went on apace. The narrative continues:

I always had an active life and pursuits out of school, when any leisure was left me. We had ample play-ground near my father's brewery. My brother Abram was only a few years older than I. He was very clever at all boyish games, tricks, and small mischiefs; full of fun; a builder of rabbit-houses, and keeper of rabbits; passionately addicted to brass cannons and pistols, and the use of gunpowder in all its forms; and I followed him, a willing pupil. There were a number of boys, sons of workingmen, living in the neighborhood, who formed our companions in play; but no boys of the genteeler classes were within our reach, the brewery lying close to Westport and Grassmarket, and far from the new town. I too built a rabbit-house, and bought a pair of rabbits, which soon had a numerous progeny. The procuring food for them and cleaning their house were occupations, and the warm attachment I felt toward them was a source of great gratification. On two occasions, however, I grossly mismanaged them—one culpably, the other through kindness ill-directed, but both leading to results from which I subsequently drew instruction. The first fault was neglecting to clean their habitation. Under the pressure of other duties I neglected this one, and merely covered over the old litter with fresh straw. In the course of time the female killed her young, and the buck was savage. This infanticide occurred again and again, and, true to the spirit of the age, I held up the slaughtered young before the mother's eyes and beat her well, but did not clean her bed. At last, when I resumed the discharge of my own duty, her aberration ceased; but at that time I saw no connection between my own misconduct and hers. Many years later the study of physiology revealed to me my sin, and carried instruction with it. The organism of the animal was injured and rendered miserable by the dirt, and nervous irritability, akin to insanity, was the result. This example I subsequently applied to the case of the human poor, and saw in the deleterious physical condition in which many of them habitually live the cause of some of their sufferings and crimes.

In the other instance, my compassion was moved by the supposed sufferings of my pets from intensely cold weather; and I obtained leave from my father to transfer them from the house I had built for them, with the earth for their floor, to a loft having a deal floor and thoroughly inclosed and roofed. It had only a glimmer of light through panes of thick glass inserted here and there among the tiles. To my great distress the rabbits grew sick, lost their hair; their eyes became impaired; they lost their appetite, and the buck became so miserable that I took him out to the garden, tied him to a stake, and tried my skill in marking by standing at a distance of fifteen or twenty paces and shooting him with my pistol loaded with a single ball. The ball broke his spine, and he uttered a piercing scream. The cry struck so deep into my moral nature that it overwhelmed me with pain, shame, and remorse at the time, and has never lost its character in my memory since.

Long afterward I discovered that these sufferings of my beloved rabbits were the consequences of my having, through mistaken kindness, placed them in circumstances at variance with their nature. The ground was their native floor; their fur protected them from the cold; and abundance of air and light, which they enjoyed in their habitation which I had made for them, were indispensable to their well-being: and these were all wanting in the lofts. The instruction I drew from these occurrences was that, without knowledge of the structure and functions of a living organism, and its relations to the natural ob-

jects to which it is adapted and which influence its conditions, the best intentions may inflict only suffering when pleasure is meant to be given; and that this holds as true in the case of human beings as in that of rabbits.

His father took a high Tory newspaper, and its chronicles were both intelligible and interesting. It was full of wars and rumors of wars, hangings, floggings, burnings, and slayings, and these were illustrated from time to time by doings in the town. He saw panoramas of battles, celebrations of victories, public floggings and hangings, and heard the running accompaniment of discussion among the workmen in his father's brewery. But the war was the great educator. He and his brothers had cannons of all sizes and sorts, and, as they grew up, pistols. Cartridges were given them, and they spent their spare pence for powder, lead, a bullet-mould, and a ladle. He says:

We kept the neighborhood in disquiet with the noise of explosions, and when it was found that we used balls there was fear that we should injure ourselves. And there was risk. I was firing at a mark on the inner side of the door of my father's garden, having locked it to prevent accident. The door was so thick that bullets lodged in it; but on one occasion I struck a knot which the ball drove out and made a large hole. No harm came, as no one was passing, but I quietly bought a piece of putty to fill up the hole and some brown paint to paint it over, and the evil deed was never discovered. I got a foot of the butt end of a common musket, mounted it on a stock and wheels, put it on an ale-cask, pointed it at a mark eighteen inches square supported on a stalk, and fired till I knocked it to shreds; but my crowning glory was the actual firing with my own hand of one of the great guns of the half-moon battery of Edinburgh Castle. I made friends with a bombardier who put the port-fire into my hand and gave the word "fire," and the welkin roared with the report of the gun. I was then not more than twelve years old, and to me there was grandeur in the exploit.

Then, again, in the neighborhood of the brewery were tan-works, currying-shops, an iron-foundry, a pump-maker's yard and a blacksmith's shop which he frequented, observing what was done in them and mastering the theory of their operations. He understood the business of the brewery, and all sorts of incidents constantly occurring afforded practical illustrations of the principles he had learned. In this way he added to his general intelligence and kept active his understanding, which was sent to sleep at school.

He had an intense love of nature, and of whatever displayed power and contrivance. He says of a dam-head where the water fell twenty feet:

I have stood in a pouring rain, thrilled with delightful emotion, gazing on the thundering cataract, for such it seemed to me. At a later period the falls of Niagara did not excite a stronger feeling of the sublime than did this waterfall of my childhood.

His four years of suffering under Mr. Fraser came to an end in 1801, and, when he left the class-room for the last time, he says:

I ran down the stair three steps at a time, in an ecstasy of pleasure; and on

leaving the yards turned round opposite the building and wished to God that I had the command of a battery of twenty-four pounders for a day to blow the school to atoms. For years after I left the school, when I saw my teacher coming in the street, I took the opposite pavement.

So much for the education that had been ordered and paid for. His estimate of his schooling for the next two years is equally interesting. From the High School he went to the University of Edinburgh. With his first teacher he studied geography and mathematics, but, as his capacity for learning words was slender, he forgot yesterday's lesson in learning to day's, while in mathematics the demonstrations he repeated evaporated as fast as they were learned. But for several months his sole fellow student in geography was a young sailor from the middle ranks, who was very profligate, though bold and generous, and he related to Combe the histories of his corrupt experiences. Happily, however, they had no allurements for the lad, and increased his knowledge without subverting his morals. Of his experiences in Dr. Hill's Latin class, he says:

I could not master the lessons, and had no assistance at home. As we were now young gentlemen, there was no corporal punishment, no place-taking, no keeping-in. Those able and willing to learn were taught, the rest were left unmolested, if they kept quiet and let business go on. The boys in my condition took back seats, and let the clever boys sit in the front ones next the Professor.

He and they went on harmoniously and successfully; Combe listened, and learned what he could. But he says:

I must record one great benefit I derived from the lax discipline of all my teachers in the years 1802–'3. In those years my brain got nearly a complete rest; and as I was growing rapidly this was an advantage which in its ultimate consequences counterbalanced my losses by habitual indolence. I had a conscience, and in all my previous attendance at school it urged me to do my best, and punished me with painful upbraidings when I sacrificed duty to pleasure, which was not often; and thus my nervous system had been kept on the stretch, my brain had been overtasked and my health and growth impaired. But in these two years my brain got a rest, for my conscience was to some degree involved in my general apathy.

We have no room for details of his Sunday training. Like all the rest of his so-called education it was unintelligible, burdensome, discouraging. He envied the cattle that had no souls, and he envied his brother Abram, whose light disposition enabled him to throw Calvinism to the winds, and make witty sarcasms and jokes out of the materials it afforded. In 1802 he lost a brother, ten months old, of small-pox, and in 1807 a sister just younger than himself, who had been ill for many years. These events excited and bewildered him, but the example of his parents taught him not to complain of sufferings "sent by the hand of God."

He says that about the year 1802–'3 he first became conscious of

the desire for fame, and used to shed tears of sorrow at the thought that this wish could never be gratified, as he had no special talent for any pursuit and his social position was also against him. He attributes this feeling partly to his natural temperament, and partly to his Latin studies, such as they were. During these years he taught his younger brothers and sisters for one hour each evening, except Saturdays and Sundays, for which his father paid him a small fee quarterly. As he had himself been taught almost nothing, he had a poor idea of his performances as a teacher, although his parents and pupils were satisfied with his efforts.

At the age of sixteen he had to face the question of a calling. He was feeble, delicate, shabby in appearance, with no conscious bias, but only the wish to live by honest industry. He was offered as an apprentice to a dealer in woolen cloth, flannel, and small wares, but the proprietor, he says, "took me to the door to obtain light to view me better, and turned me round and round: he then politely told my father that I would not suit." On the way to the shop of another cloth-merchant they met one of his uncles, who was told where they were going, and what had happened at the former application. This uncle now suggested to the father that they try the law, "For," said he, "you have given George a good education: we have a numerous connection in town, and there is no writer among us." The father was afraid they could not succeed with this idea, but it ended in his going as an apprentice for five years to a "writer to the Signet," one Alexander Dallas. He had to bring a certificate from Professor Hill, of his attendance at the college for two years. He was terribly alarmed lest Professor Hill should decline to do this because of the utter neglect of his studies during those two years, but was astonished at the close of the session to get the following document:

EDINBURGH, *April* 18, 1804.

That the bearer, Mr. George Combe, attended the Humanity class in the University of Edinburgh two years, and prosecuted his studies with great diligence and success, is attested by

(Signed) Jo. HILL, *Lit. Hum. P.*

Although this certificate gained him the place, the autobiography closes by explaining how completely his schooling had unfitted him for it. His first experiences in the study of law were extremely painful and mortifying. Some degree of independent judgment in the use of words was now required, and of this he was wholly destitute. He had to begin anew his literary education, but by unwearied industry and perseverance he at length aroused his dormant faculties and learned how to use them. Combe thought his helplessness was due to the fact that at school he was taught nothing; but children nowadays are rendered equally helpless by over-teaching. They get abundant instruction and but little education. Our youths leave school as incapable of independent thinking as was Combe himself. With all our boasted progress empty-headed teachers still abound, and the failure of

children in repulsive tasks is still punished, less grossly than but often quite as cruelly as ever. In Combe's time "children," he says, "were ordered to learn, and scolded and punished if they did not get their lessons." Does not this pretty fairly describe the present state of things? Most parents still think, with the elder Combe, that to educate is to send to school, and the experience of George Combe should do something toward dispelling this prevalent error.

SKETCH OF PROFESSOR W. D. WHITNEY.

WILLIAM DWIGHT WHITNEY was born at Northampton, Massachusetts, February 9, 1827. He received an academic education at Williams College, in the same State, graduating in 1845. On leaving college he became clerk in a banking-house, and continued in this employment for about five years, devoting his hours of leisure to the study of languages, but particularly of Sanskrit, the ancient language of India. In 1850 he visited Germany for the sake of enjoying the exceptional advantages afforded by the universities there for the pursuit of linguistic studies. For three years he attended in the Universities of Berlin and Tübingen the lectures of the foremost philologers and Sanskritists of the time, namely, Professors Bopp and Weber, of Berlin, and Roth, of Tübingen. In conjunction with Professor Roth, he prepared an edition of the text of the "Atharva Veda Sanhita," which was published in 1856 at Berlin. Whitney transcribed the text from the MS. in the Royal Library at Berlin, and collated it with the MSS. of the Libraries of Paris, London, and Oxford. In a second volume, which is in course of preparation, the editors will publish a translation of the work, with commentary, notes, and index. Since 1849, when he became a member of the American Oriental Society, he has distinguished himself among all his associates in that learned body by the number and the value of his contributions to its "Transactions," and his untiring efforts to promote the objects for which it was founded. He was Librarian of the society from 1855 to 1873, and has been its Corresponding Secretary since 1857. Of volumes v. to ix. of its "Journal," more than one half was contributed by him. He was in 1854 appointed Professor of Sanskrit, and in 1870 Professor of Comparative Philology, at Yale College, which chair he still occupies. In 1858 he edited, with notes, the republication of Colebrooke's "Miscellaneous Essays," which have principally to do with subjects connected with Sanskrit scholarship.

Besides contributing voluminously to the "Journal" of the American Oriental Society, he is the author of several critiques and essays published in sundry journals, American, English, and German. Among

the more important papers either written or edited by him, and published in the "Journal," may be named Rev. Ebenezer Burgess's translation of the "Sûrya-Siddhânta" (a Hindoo treatise on astronomy) 1860, with notes and an appendix; text, with notes, of the "Atharva-Veda Prâtiçâkhya" (1862); the text of the "Taittirîya Prâtiçâkhya" (1871), with English version, notes, and native commentary, the last two being grammatical treatises—the edition of the "Taittirîya" won for Professor Whitney from the Berlin Academy the Bopp prize—reviews of Lipsius's phonetic alphabet and of the opinions of Biot, Weber, and Müller on the lunar zodiac of India, Arabia, and China. He was a contributor to the great Sanskrit Dictionary of Böhtlingk and Roth (St. Petersburg, 1853–'67, seven volumes). In 1869 he aided in founding the American Philological Association, and was its first President. His work, "Language and the Study of Language" (2 vols., 1867, republished in 1874), was made up of a series of lectures, delivered first at the Smithsonian Institution, Washington, and repeated at the Lowell Institute, Boston; it was translated into German, and edited, with additions, by J. Jolly, under the title of "Die Sprachwissenschaft" (Munich, 1874). His principal contributions to the "Journal of the American Oriental Society," "The North American Review," "The New-Englander," and other periodicals, were collected and published in two volumes, entitled "Oriental and Linguistic Studies" (1873–'74). To the "International Scientific Series" he contributed a volume in 1875, entitled "The Life and Growth of Language," which was very favorably received both at home and abroad, having been translated into French, German, and Italian. He has prepared several school manuals for the use of students of the German language, viz., a grammar, a reader, a dictionary, and texts of certain of the German classics. In 1877 appeared his work, "Essentials of English Grammar." He has now in press, in Leipsic, a Sanskrit Grammar, in English and German editions.

We append a list of papers published at various dates by Professor Whitney, but not contained in either of the two collections named above: "Material and Form in Language" (1872); "φυσει or θεσει"—"Natural or Conventional" (1874); "A Botanico-Philological Problem" (1876). The foregoing were published in the "Journal of the American Philological Association." Peile's "Greek and Latin Etymology" (1873–'74; "Transactions of the London Philological Society"); "On the History of the Vedic Texts" (1854; "Journal of the American Oriental Society"); "Contributions from the Atharva-Veda" (1856; in the same journal); on Lipsius's "Standard Alphabet" (1862; the same); "On the Jyotisha Observation of the Place of the Colures and the Date derivable from it" (1864; "Journal of the Royal Astronomical Society," London); "Are Languages Institutions?" (1875; "Contemporary Review"); "Müller's Rig-Veda and Commentary" (1876; "New-Englander"); "The value of Linguistic Science to Ethnology" (1867; in the same).

CORRESPONDENCE.

ON THE FEAR OF DEATH.

To the Editors of the Popular Science Monthly.

AN interesting article entitled "The Fear of Death" appeared in "The Popular Science Monthly Supplement" for December. The author in one place says: "At any rate the feelings with which we contemplate the termination of our own earthly life must vary indefinitely in different individuals, and in the same individual at different times; and it would be a matter of deep interest to compare our respective experience if we could bring ourselves to do so." Having been myself quite recently very near to the entrance of the "valley," and having been for a long time in the daily habit of mentally viewing the question of the extinction of life, it has occurred to me that, where the subject is one in which we all have an interest more or less, even my small experience may be in some degree useful and suggestive.

When quite young, too young in fact to have any definite idea of what death means, I had an extreme dread of the very thought. At the age of six years I stood for the first time in the presence of death, having been brought into the room to see the body of a deceased lady who had been very kind to me. I was awe-stricken. I could not imagine what had occurred. I was told in a subdued voice that she was dead. I did not understand it; I only saw that some terrible and to me inexplicable change had taken place in my friend, and for a long time afterward the mention of death filled me with childish horror. The thought that I too should one day be like that was unbearable.

In early manhood I had a reluctance to think on the subject of death at all, and whenever the repulsive idea presented itself I dismissed it as quickly as possible.

On one occasion, when about twenty-one years old, I accompanied, merely as a spectator, a military expedition against the Taiping rebels in China. During the space of an hour or so I found myself under fire, and, being a novice in the business of war, I felt decidedly uncomfortable. If freedom from apprehension of personal danger constitutes bravery upon such occasions, then I was not by any means brave. But during the whole time I was not conscious of any anxiety as to death or what may follow it; my chief thought was: "If I am hit, what will be the sensation? will it be very painful?" The paramount solicitude was for my *body*, and if my general anxiety included any other elements than the fear of *pain*, certainly that was the predominating one. Being only a looker-on, and having no active duties to occupy my mind, I remember distinctly my feelings upon that occasion.

Again, later on in life, I was caught in a heavy blow one night on our Southern coast. The vessel, a small schooner, was in ballast, and we were drifting rapidly to leeward toward the shoals which line the part of the coast where we were; we missed them by the merest chance.

All through that night the thought of death was present in my mind, my anxiety increasing with every cast of the lead, which showed the constantly lessening depth of water. Yet here, again, the fear of the *manner* of death was stronger than the fear of death itself. Of course, there were feelings of sadness connected with the thought of being cut suddenly off from relatives and friends, but still the chief apprehension was concerning the hopeless and seemingly inevitable struggle in the breakers before death should supervene.

As I approached middle age, the subject of death and what may possibly succeed it began to form more and more a part of my studies and to occupy more constantly my thoughts. The difficulties in the way of an unquestioning belief in a future state of existence beyond the grave increased the more the subject was studied, but the fear of death was if anything lessened. I was told that sickness and the approach of death would alter my views in that respect, and at last I began myself to have a curiosity to learn whether such a result would really follow upon the loss of health.

Not long ago I had a very severe illness, from which I have not yet quite recovered, and perhaps never shall. For a time my chances of life were very small, and I realized my condition perfectly; yet, the nearer Death approached, the less grim and repulsive he appeared. The principal feeling was one of resignation, or perhaps some would prefer to call it apathy. There was, however, always present with the idea of death a certain curiosity as to how the change would be effected, and what it would be followed by—whether by annihilation of all sensation, or by an extension of consciousness of identity with a higher development of faculties and perceptions. While the latter conception was the more pleasing, truth compels me to say that the former appeared to be the more probable.

The difficulty of making a mental presentment of a state of conscious identity

apart from the body and brain seemed insuperable, and to believe sincerely and without a doubt that which is inconceivable is, at least in my own case, impossible.

Doubts regarding the question of immortality gave me no concern as to consequences. Those doubts are honest, and I can not prevent them. I was and am convinced that if what I was taught in my youth concerning God and a future life be true, an All-wise and All-just Supreme Being can not condemn me for believing according to the best light of the intellect which he himself gave me; while, if the doctrine of immortality be false, then of course death ends all. In either case there is no cause for uneasiness. Since my partial return to health, the wish to live has strengthened; in fact, now that I am able to attend to my daily business, the state of my health gives me more concern than it did at a time when I was too weak to walk across the floor. On the whole, I think that the fear of, or rather the repugnance to death, varies directly with the vicissitudes of health—strongly developed in robust health, decreasing gradually as death draws nearer. It is well that it is so. J. J. F.

New York, *December* 22, 1878.

EARTHWORMS, Etc.

To the Editors of the Popular Science Monthly.

I had the good fortune during the past summer to witness a remarkable display of reason, or something quite akin to reason, in an earthworm. I was watching a number of them in my garden after a shower, as they swallowed bits of dry grass and leaves, when I observed one of very large size take hold of a stick about six inches long. He took hold as he reached it, by the middle, and drew it toward his hole. But as the dirt was heaped up near the hole, the stick soon became bedded about an inch, and then resisted the persistent efforts of the worm to draw it farther. He then deliberately let go of the middle and felt along to the end of the stick, which he seized and drew easily to his retreat. I watched until it had partially disappeared in the hole, but was unable to determine the special value of the prize. It is likely that he desired to feed on the decayed bark of the stick, as I have observed that these worms almost invariably eat dried food instead of green.

By the way, have you ever had your attention drawn to the circulation of the *Caladium esculentum?* You will observe at the tip of a thrifty-growing leaf, on the upper side, a small hole, in which you can insert the point of a pin. Now water the plant abundantly, and shortly you will observe a small globule of water leap out of this hole. Nine of these combine to make a drop, which falls off and is replaced by another. In a short time quite a pool of water will be found under the plant.

E. P. Powell.

Clinton, New York, *January* 20, 1879.

EDITOR'S TABLE.

MORALITY AND EVOLUTION.

It is announced that Herbert Spencer has ceased writing upon his "Sociology," and begun the "Principles of Morality," the last of his series; and it is inferred from this that, having found his "Synthetic Philosophy" overgrown and unmanageable, he has abandoned a part of it in order to finish the rest. This is an entire misapprehension. He has never had his great work so completely in command as now. His suspension of labor upon the sociological division is but temporary, and he anticipates a part of the final ethical discussion for reasons quite other than those assigned. The step has been taken in consequence of Mr. Spencer's uncertain health, and from an apprehension that he might break down before reaching its concluding part. Regarding "The Principles of Morality" as the most important portion of his undertaking, to which all the preceding works are preliminary, he felt it to be of great importance to prepare such a statement of his ethical views as will show the bearing of the previous parts of his system upon that subject. He accordingly some months ago stopped work upon the second volume of the "Sociology," and began "The Data of Ethics," the first portion or groundwork of "The Principles of Morality." This is now so nearly finished that it may be expected to appear in a small volume of two hundred and fifty pages in the course of the spring, when Mr.

Spencer will resume the course of his labors upon "The Principles of Sociology."

The appearance of a new book upon morals is now so common a thing as in itself to be hardly noteworthy. But the publication of such a work, at the present time, by the most eminent expositor of the doctrine of evolution, and the only man who has dealt with that doctrine as the basis of a comprehensive philosophy which is broadly founded upon the results of modern science, and treated throughout with reference to the ultimate establishment of the principles of right and wrong in human conduct—such a book will be certain to attract wide attention.

Morality, as is well known, is a subject that has been hitherto kept in very close connection with theological beliefs. It has been generally taught by the dogmatic method, and as based upon supernatural sanctions, so that the theologians have come to be regarded as its legitimate custodians. Not only is the inculcation of morality a conceded prerogative of the pulpit, but the regular teaching of it, in nearly all our higher education, is also in the hands of the divines. In an interesting and instructive paper published in "Mind,"* by Mr. G. Stanley Hall, on "Philosophy in the United States," the writer remarks of the three hundred non-Catholic colleges in the country as follows: "In nearly all these institutions certain studies, æsthetic, logical, historical, most commonly ethical, most rarely psychological, are roughly classed as philosophy, and taught during the last year almost invariably by the president." To this it may be added that the president is almost invariably a doctor of divinity. These theological expounders of studies "most commonly ethical" ever insist upon the vital interdependence of theology and morals. It is taught that they are bound up together indissolubly and are subject to a common fate, and this is the way the subject is regarded by the great mass of people in the community.

But we are now called upon to take into account a most important fact. There is an undeniable and widely spread decay of theological dogmas affecting all classes of society. The old adherence to traditional beliefs is weakening, and men are falling away from their creeds. The ancient sphere of belief and faith is invaded by science, and is being inexorably circumscribed. This is notorious, and is acknowledged by eminent religious authorities.

In a paper of remarkable candor and significance, by the Rev. Phillips Brooks, of Boston, in the March number of the "Princeton Review" on "The Pulpit and Modern Skepticism," the writer admits that the phenomena of doubt "are thick around us in our congregations, and thicker still outside our congregations, in the world." This skepticism he recognizes as "a very pervading thing. It evidently can not be shut up in any guarded class or classes. Life plays upon faith everywhere. Ideas change and develop in all sorts and conditions of men; and the occupants of pulpits have their doubts and disbeliefs as well as others." Again, "a large acquaintance with clerical life has led me to think that almost any company of clergymen, gathering together and talking freely to each other, will express opinions which would greatly surprise and at the same time greatly relieve the congregations who ordinarily listen to these ministers."

And again: "How many men in the ministry to-day believe in the doctrine of verbal inspiration which our fathers held, and how many of us have frankly told the people that we do not believe it, and so lifted off their Bible's page the heavy cloud of difficulties and inconsistencies which that doctrine laid there? How many of us hold that the everlasting punishment of the wicked

* Reprinted in "The Popular Science Monthly Supplement," New Series, No. 1.

is a clear and certain truth of revelation? But how many of us who do not hold that have ever said a word to tell men that we thought they might be Christians, and yet keep a hope for the souls of all God's children?"

Dr. Brooks remarks still further: "There must be no lines of orthodoxy inside the lines of truth. Men find that you are playing with them and will not believe you even when you come in earnest. I know what may be said in answer. I know the old talk about holding the outworks as long as we can, and then retreating to the citadel, and perhaps there has hardly been a more mischievous metaphor than this. It is the mere illusion of a metaphor. The minister who tries to make people believe that which he questions, in order to keep them from questioning that which he believes, knows very little about the certain workings of the human heart, and has no real faith in truth itself. I think that a great many teachers and parents now are just in this condition. They remember that they started with a great deal more belief than they have now. They have lost much, and still have much to live by. They think that their children, too, must start believing so much that they can afford to lose a great deal and still have something left, and so they teach these children what they have themselves long ceased to believe. It is a most dangerous experiment."

We have quoted these frank and impressive passages because they will have weight as coming from a distinguished religious teacher. They reveal no secret, and state nothing that observing persons did not know before; but they bring out clearly the degree to which religious dogmas are already discredited and secretly abandoned, and they painfully illustrate the insincerity and duplicity that have resulted.

But what we have here to note is simply the acknowledgment of the extent to which theology is losing its hold upon the general mind, and untenable articles of religious faith are being abandoned. It is this crumbling theological system that has been hitherto offered us as the foundation of morals. Religion and morality, as we have said, are held to be bound up in a common fate, and to the great majority of people religion means orthodox theology. These will therefore naturally think that, when their articles of faith are discredited, morality must be discredited also. We are thus forced by the critical exigencies of thought to meet the question, Is morality to fall with the decaying authority of supernaturalism, or does it really rest upon another and more immutable foundation? In fact, the broad issue is, Does morality belong to the domain of theology or to the domain of science, and is it to be treated by theological methods or by the methods of science? Answers to these questions are now imperatively demanded.

It may be objected that this is an empty requirement, as we already have a distinctly recognized ethical science cultivated by rational methods—the utilitarian system, based upon experience, and rejecting all theological implications. It is true that there is a strong tendency of thought in this direction, but it is neither the prevailing mode of viewing the subject, nor does it make any claim to be based upon the results of modern science. Mr. Sidgwick's recent book, "Methods in Ethics," in which he undertakes to examine and criticise the grounds of ethical systems, does not deal with the relations of modern science to the subject, and in this respect it was disappointing to many. Those familiar with the drifts of recent inquiry perceive that the course it has taken and the results it has attained must profoundly affect the philosophy of morals, if indeed they do not give us a "New Ethics"; but Mr. Sidgwick seems but little more conscious of any such movement than were Bentham and Mill. He is not of course to be blamed, as he deals with past systems, but his work is proof that no close relation between

general science and ethics has hitherto been systematically traced out.

The most far-reaching and radical revolution in thought of which we have yet had experience consists in the extensive acceptance of the doctrine of evolution. That this doctrine has fundamental relations with morality is undeniable. Those theological teachers who hold that religion and morality are so unified that they must stand or fall together are fond of insisting that evolution is fatal to both. This is very much like a desperate abandonment of both to destruction, for the theory is making headway at a rate unprecedented in the historical growth of opinion. It has been developed by studious scientific men, and promulgated like any other scientific conclusion to which they have been led by the established processes of investigation and the established rules of logic. All our science is pervaded by it, and there is no hope that it can be arrested. It is therefore important to know what it is going to carry away, what it is going to leave, and what it is going to give. Will it subvert morality, or will it lead to a higher morality?

The answer to this question we can not regard as doubtful. If evolution be true, and man's ethical nature is no exception to the general constitution of things, then evolution is the agency that has developed morality in the past and brought it to its present condition. Assuming that the principles of right and wrong and the laws which regulate human conduct are rooted in the natural order, the sciences of nature which explain that order must have close bearings upon the philosophy of human conduct, while the profoundest interpretation of the method of the universe that has yet been attained, and which throws a flood of new light upon the nature of man and the development of humanity, must certainly aid us in the study of human activities in their highest aspects.

At any rate, we desire to have a report upon the present state of knowledge on this important subject, and we want it from a man authorized to speak. Mr. Spencer's book on "The Data of Ethics" may be expected to give us the scientific groundwork of the subject in connection with the principle of evolution, and it can not fail to prove helpful to many minds, both by the instruction it will afford and by the solicitude it will dispel in the present state of transitional opinion.

THE LATE DANIEL VAUGHAN.

We print this month the last of a short series of very interesting articles on astronomical subjects by Professor Daniel Vaughan, of Cincinnati. Before we had received from him the corrected proofs of the last article, news came that he was dead. We were of course startled by this intelligence, as his death is a profound loss to American science, and we knew that he was by no means a very old man, and were not aware of his failing health. But there now come to us certain painful disclosures regarding his life, of which it is desirable to take notice.

Daniel Vaughan was born in Ireland, of wealthy parents, about the year 1821. He had a good education from a tutor, and at the village school, and was noted for mathematical ability. He came to this country at the age of sixteen, and went directly West, becoming the teacher in a country school in Bourbon County, Kentucky. Here he studied in seclusion, and made great proficiency in the higher branches of scientific study; but, famishing for books and intelligent associations, he went to Cincinnati twenty-five years ago, mainly attracted by its library privileges. He now pursued a wide course of scientific inquiry with great vigor and enthusiasm, devoting himself mainly to astronomy and to the larger aspects of natural phenomena, which he treated with the freedom and independence of a strong orig-

inal thinker. He was master of the German, French, Italian, and Spanish languages, and also of ancient and modern Greek. He wrote one or two volumes upon mathematics and astronomy, and contributed numerous papers to the proceedings of learned societies, and to scientific periodicals at home and abroad. An example of the wide range of his studies and publications is afforded by the following list of papers and articles which appeared at different times and in different publications:

"The Doctrine of Gravitation," "The Cause and Effects of the Tides," "The Rings of Saturn," "The Light and Heat of the Sun," "The Origin and the End of the World," "The Advent and Appearance of New Stars," "The Asteroids," "The Nebular Hypothesis," "The Secondary Planets," "The Plurality of Worlds," "Stellar Astronomy," "Meteoric Astronomy," "The Remote Planets," "The Moon," "Earthquakes," "Volcanoes," "The Deluge," "The Sources of Power accessible to Man," "The Distribution of Metals," "The Geography of Disease," "The Abuses of Science," "The Absence of Trees from Prairies," "Surface Geology," "The Primitive Earth," "The Ancient Atmosphere," "The Silurian Strata," "The Carboniferous Formations," "The Origin of Lakes," "Origin of Mountains," "The Causes of Rain, Winds, and Storms," "History and Nature and Uses of Electricity, its Agency in Nature," "Galvanism," "Magnetism," "Ocean Currents," "The Life of Newton," "Of Laplace," "The Physics of the Internal Earth," "Determination of Planetary Distances," "Geographical Advantages for National Ascendancy," "Physics of the Internal Earth," "Discovery of Neptune," "Revelations of Spectrum Analysis," "The Theory of Probabilities in the Detection of Crime," and "The Catastrophes in Celestial Space."

Professor Vaughan was a correspondent of various eminent scientific men abroad, who had a high opinion of his abilities, and many of his papers were translated into the Continental languages.

One might suppose that so learned and accomplished a man, whose name gave distinction abroad to the great city of his adoption, would have been favored and honored by its intelligent and public-spirited citizens, and placed in a position so independent as to afford the best play to his remarkable powers. There is wealth to squander in Cincinnati on all projects and in all ways, as becomes a boasting city of the West in hot rivalry with St. Louis and Chicago, so that one would think it might fitly have taken decent care of its most illustrious scientific man. But it turns out that Professor Vaughan was most scandalously neglected; he led a life of pinched privation, was left to get a precarious subsistence by private teaching, and was cheated out of his earnings by the colleges in which he lectured and who got the benefit of his eminent name. We do not like to say that Professor Vaughan literally starved to death in Cincinnati, but he led a life of suffering and want, which the past inclement winter brought to a close in a hospital, and we are told that "an autopsy revealed the wreck of his vital system and proved that the long and dreadful process of freezing and starving had dried up the very sources of life."

We gather the main particulars here given from an article in the "Cincinnati Commercial" of April 7th, written by Mr. William M. Corry, a friend of Professor Vaughan, and subjoin from his communication the following extracts:

For years some kind woman, whose name we are sorry not to know, boarded and lodged Professor Vaughan, and gave him more sympathy than he got from all the rest of the town, and more also of substantial support. He was always sure of a pleasant reception at her humble home, and was not required to be punctual in his settlements. The boarding-house was broken up a year or two ago, and our poor friend was the worst sufferer. He took a room which was cheap, but every way cheerless, inaccessible, and uncomfortable. A chair and a bedstead with a pile of rags, a worn-out stove, and an old coffee-pot, with a few musty shelves of books, covered with soot, were all his fur-

niture. He lived, sick and feeble and old, from hand to mouth, often unable to go abroad for food, and as badly off for helping himself indoors. It were bad to have any human being so utterly abandoned, and so suffering. Here and there, at wide intervals, there was a man or woman who would have done much to modify this misery, but it ought never to have been left to those who could scarcely afford to curtail their own allowance of plain clothes and victuals for another.

His arduous literary labors were performed without any compensation whatever. (It may be said in this connection that he has recently been paid to his satisfaction for several essays over his name in "The Popular Science Monthly." A most pathetic incident of the last one is that, the very day before his death, he sat upon his bed and corrected the proofs, which ought to have been done for him, but which he would never ask any one to do, and which, if it did not cost him his life, without doubt shortened his few remaining hours.)

Mr. Corry indignantly adds: "There can be no doubt that the city has incurred a deep and lasting reproach by permitting such a treasure to be destroyed prematurely by disease and actual want, and that she should be told of it, and should suffer the consequences."

There is, however, this palliation for the conduct of the Cincinnatians. Professor Vaughan was modest, shrinking, and unobtrusive, and kept his miseries to himself. "He would not give his address to his friends, nor permit them to ferret him out and ascertain with their own eyes his actual condition. Nor would he make any explanation, much less ask or accept any pecuniary assistance." That is, he did not choose to submit to the mortification of becoming an object of charity. No doubt there were plenty of people who would have given alms, if it had been solicited, but the man's self-respect would not permit the degradation. It is said he neglected himself, and his townsmen merely imitated his example; but this is rather a cold-blooded apology for leaving a man of genius to penury, rags, and starvation. Read over the list of subjects upon which he thought and wrote, and read the first paper in this "Monthly," which shows the quality of his work, and then say how much vigor a man would have left to fight his Cincinnati neighbors in the competitions of money-making. He was incompetent to make money by his very vocation, and this must have been perfectly well known. Why was not a proper place made for Professor Vaughan, in which he could have given his services to the public, and been so fairly paid for it that he could have lived in a way to favor his best work? The answer is, that there was not sufficient appreciation of science among the people; and very likely, if by special exertion he had been put into a comfortable place, some miserable mountebank who knew better how to manage the public would have got the position away from him.

LITERARY NOTICES.

COOLEY'S CYCLOPÆDIA OF PRACTICAL RECEIPTS AND COLLATERAL INFORMATION IN THE ARTS, MANUFACTURES, PROFESSIONS, AND TRADES, INCLUDING MEDICINE, PHARMACY, AND DOMESTIC ECONOMY: Designed as a Comprehensive Supplement to the Pharmacopœia and General Book of Reference for the Manufacturer, Tradesman, Amateur, and Heads of Families. Sixth edition, revised and partly rewritten by RICHARD V. TUSON, F. C. S., Professor of Chemistry and Toxicology in the Royal Veterinary College. Vol. I. New York: D. Appleton & Co. Pp. 896. Price, $4.50.

THE rapid development of the practical arts in all directions in recent years has made it lively for the book-makers, because no sooner is a formidable treatise finished on these subjects, no matter with what painstaking care to bring it up to date, than it quickly falls behind, and the author has to set himself to work to prepare for the inevitable new edition. Time is but the register of change; change brings improvements, and improvements antiquate cyclopædias. And so it begins to be understood that no literature is so perishable as that which deals with facts and solid reali-

ties. This would be discouraging for book-makers and book-sellers, but for the circumstance that the old editions become soon worthless, and new ones indispensable. And it would be hard on the book-buyers, but for the fact that the new improvements are often so invaluable as to be cheap at almost any cost. We can not stop the growth of the arts in order to keep the treatises that we have bought perennially fresh.

Cooley's "Cyclopædia of Practical Receipts" is a work of high reputation, not only for its comprehensiveness and accuracy, but because it has been kept faithfully up to the times by its successive revisions; and a careful examination of the sixth edition shows that its standard of excellence has been strictly maintained. The title "Receipts" is in some respects unfortunate, as the work is by no means a mere receipt-book, and it makes no clap-trap claim on the ground that its receipts can be counted by the thousand. It abounds in important practical information of general interest in reference to the materials furnished by commerce and used in the arts, their preparation, and their purity, and is very full in illustrated directions for carrying on manipulations, and preparing numerous articles and products of general utility. The work is important to the chemist, the mechanic, the manufacturer, and the householder. It will be completed in two volumes, and the second may be expected to appear in a few months.

HEALTH, AND HOW TO PROMOTE IT. By RICHARD MCSHERRY, M. D., Professor of Practice of Medicine, Maryland University, President of Baltimore Academy of Sciences, etc. New York: D. Appleton & Co. Pp. 185. Price, $1.25.

DR. MCSHERRY has here made both a readable and a useful little manual of hygiene. He has no hobbies, and does not profess to be the author of any new theories for the preservation of health, but he goes over the general ground of its conditions as affected by education, as related to the sexes, and as influenced by clothing, exercise, diet, and the habitual use of stimulants. Upon these topics there will be found much fresh information, with many judicious extracts from the best authorities, derived from wide and critical reading. The author's pages are enlivened with many personal references, and interspersed with acute observations calculated to please as well as to instruct the reader. The book will well repay perusal, and we heartily commend it.

AFTER DEATH, WHAT? OR, HELL AND SALVATION, CONSIDERED IN THE LIGHT OF SCIENCE AND PHILOSOPHY. By Rev. W. H. PLATT. San Francisco: H. Roman & Co. Pp. 209.

THIS is decidedly a lively volume. It is a sort of colloquial symposium; that is, it undertakes to present both sides of a controverted subject, or some of the issues of religion and science. Yet it differs from the symposium proper, in that the discussion is carried on conversationally, and still more that both sides are represented by one partisan. The book is written by a clergyman, and takes the form of a debate between a preacher and a skeptic. The skeptic seems a kind of poor stick, made to order for the convenience of the preacher, who cuffs him about in a very unceremonious way, and finally "converts" him.

The theory of the origin of the book we are half inclined to infer may be something like this: Rev. W. H. Platt is Rector of Grace Church, San Francisco, which is no doubt a sound and we trust a prosperous orthodox establishment. It is quite likely that, in that city of hoodlums, Chinese pagans, and wicked doubters, some graceless persons have poked fun at the Grace Church people about their antiquated, superstitious notions of hell. Now, even the regenerate are liable to suffer from lingering remnants of pride, and do not like to be made fun of; and so, we may suppose, they turned to their shepherd, Rev. W. H. Platt, for protection. Whereupon, it may be further assumed, he rose in some wrath and resolved to give these scoffing skeptics more scientific hell than they had ever had of the theological sort. We vaguely conjecture this situation from the first paragraph of the book: "The scientist boldly asks the preacher why he continues to preach the old-fashioned hell. 'Do you not know,' he says, 'that intelligent people now laugh at your lake of fire and brimstone, your devil with horns and dragon-tail, and all that sort of stuff?'"

The discussion is thus launched, and the author proceeds to get such abounding proofs of hell out of the most modern science as must raise the spirits of his desponding flock. The advance of science does not trouble him; he accepts its latest conclusions in the most liberal spirit, but finds them all subservient to his purpose. After proving immortality on scientific grounds, he goes on to establish that—

The law of affinity proves a hell.
The law of association proves it.
The law of growth proves it.
The law of propagation proves it.
The law of involution proves it.
The law of evolution proves it.

This is a pretty strong programme, but what does the Rev. W. H. Platt really mean by "hell"? One is led to suppose from the way he starts off that he means to stick to the literal, old-fashioned notion, and not yield to any amelioration of modern theology in regard to this important term. Indeed, he gives a side-thrust at Mr. Beecher by putting a passage from Beecher's San Francisco lecture into the mouth of his skeptic as follows: "'Any way,' said the skeptic, 'the old creed and religion must give way. There is just as certainly a change in the whole religious thought of the race as that the sun shines. Doctrines taught fifty years ago are neither taught now as they then were nor believed as they then were believed.'" This the preacher stoutly denies. But, when he says "antipathy of evil to good is hell," is he not making a new definition that would have been scouted by orthodox theologians half a century ago? Again, he says, "'Suffering makes all places hell—just as mental suffering is greater than bodily suffering so its hell is worse,' said the preacher. 'We have been taught that hell is a locality, and so it is. The shadow and the beam each have its place. But as a village is nothing to an empire, to a continent, to a hemisphere; as the center is nothing to a circumference; as a point is nothing to all space, so is the placed hell of past teachings as nothing to the unplaced hell of science. To the evil 'all places are hell.' Hell is in the presence of broken law, whether in mind or matter, in time or eternity.'"

A quarter of a century ago this would have passed for flat Universalism.

THE REIGN OF GOD NOT THE REIGN OF "LAW." By THOMAS SCOTT BACON. Baltimore: Turnbull Brothers. Pp. 400. Price, $1.50.

A PROSY, unreadable book by a very devout but foolish man, who is in a state of anxious alarm at the progress of science, and proposes to resist it by clinging with increasing desperation to the most literal orthodox interpretation of Scripture. We do not by any means intimate that the author is a fool; on the contrary, he is what is called "learned"; that is, he quotes strange lingos all through his text, and has, no doubt, been through college. He can not be strictly said to be ignorant of nature, but he is in a far worse state of mind than that of simple ignorance. There would be some hope of teaching a Digger Indian many elementary truths concerning natural things, because he has no fatal prepossessions respecting them; but this enlightened Christain has got his head so filled with the details of a great theological system, and is so palsied with fear lest it should be disturbed, that no real knowledge of nature can get entrance or hospitable reception in his mind. For example, in his chapter on our present geology and astronomy, he insists that "we may yet find that God chose to do all that work of creation in twenty-four, or in one hundred and sixty hours of our present time, which *it is absurd* to doubt that he could do." Of what use are proofs to an intellect in such a condition as this? When many years ago the fossil shells of marine life were found on the tops of high mountains, and the question arose how they came there, the monks readily replied that they were created at first in their fossil forms with the divine intention of testing men's faith in the power of God to do things exactly as he pleased. This is now regarded as sufficiently absurd, and is often quoted to illustrate the stupidity of the monks; but their frame of mind survives in our author. In a foot-note he says: "Indeed, it is far more rational to think that the eternal Lord made in a moment of time all this nature, and with its suggestiveness to the merely worldly mind of long processes of creation, meaning this as one of those mysteries of spiritual discipline which we find everywhere else, and which are greater than all matter, thus trying and training our

faith in him." What a notion of the Deity!

HEALTH PRIMERS: No. 1, EXERCISE AND TRAINING; No. 2, ALCOHOL, ITS USE AND ABUSE; No. 3, THE HOUSE AND ITS SURROUNDINGS; No. 4, PREMATURE DEATH, ITS PROMOTION OR PREVENTION; No. 5, PERSONAL APPEARANCE IN HEALTH AND DISEASE; No. 6, BATHS AND BATHING. New York: D. Appleton & Co. 1879. Pp. 96 each. Price, 40 cents.

THE deep and widespread interest that has of late years been taken in matters pertaining to the preservation of health has caused the publication, among much that is good, of a great deal that is bad on the subject of hygiene. This has usually appeared in the shape of crude and untrustworthy compilations, that when made the basis of practice have been productive of positive injury, and have led to a general distrust of all hygienic teaching. These Primers originated in a desire to change this state of things by supplying, in a form suited to the wants of the general reader, trustworthy information capable of practical use on the more important every-day questions relating to personal and family hygiene. Their preparation has been undertaken by several eminent medical and scientific men in London; the choice of topics and critical supervision of the work being intrusted to an able and responsible committee.

The series, when complete, will consist of fifteen volumes; six of these have now been published, and, as will be seen from the titles given above, they are all on subjects of the first importance. The writer in every case has been selected for his special acquaintance with the subject he was to treat, and as a consequence each Primer is filled with substantial and useful information, presented in a simple and elementary form, that brings it within the reach of the average reader.

Some idea of the valuable practical information contained in these volumes may be gained from the following *résumé* of the contents of those already published:

No. 1, on "Exercise and Training," is illustrated, and deals first with the "General Principles" of the subject; this is followed by "The Exercise suitable for Different Ages, Sex, and Physical Conditions"; and the Primer closes with a chapter on "Training," in which the relations of different dietaries to exercise, the amount of exercise required, its due regulation, etc., are considered. In No. 2, on "Alcohol," the properties of this substance are first described in an "Introduction"; then come, the forms in which it is used as a beverage; its effects when taken sparingly and in excess; the diseases it gives rise to; and its right use, if used at all. No. 3, on "The House and its Surroundings," opens with a chapter pointing out the common defects observed in houses; treats next of site and construction; then of drainage; water-supply; closets and plumbing; warming and lighting; bedrooms, kitchen, etc.; and the operations of purification. No. 4, on "Premature Death," begins with a statement of the proportion of people who die before their time; this is followed by a description of the principal causes of premature death; and, lastly, we are told what to do to secure a reasonable length of days. In No. 5, on "Personal Appearance in Health and Disease," the form and size of the body, with their healthy variations, are first described; the changes that take place in the fatty layer or tissue are next discussed; then the changes observed in the bony framework; the changes in the organs due to development, etc.; artificial alterations of shape; color and changes of color; and, lastly, temperament and habit. No. 6 treats of the "Physiological Action of Baths"; varieties of baths; bathing localities; and the uses of the bath.

DRAPER'S SCIENTIFIC MEMOIRS. New York: Harper & Brothers. 1878.

WE briefly noticed this interesting work some months ago, with the intention of recurring to it again at a favorable opportunity, to enforce some points not then considered. Meantime there has appeared a review of the volume in the "London, Edinburgh, and Dublin Philosophical Magazine," that is both so authoritative and so pertinent that we can not do better than transfer it to the columns of "The Popular Science Monthly." Dr. Draper contributed numerous articles descriptive of his important researches to the pages of that magazine at the time his investigations were made. Many of the

results which he reached were at once accepted as valid advances in the fields of Physics, Chemistry, and Physiology. But, in regard to the study of the radiations and the new results attained in that field, matters took a different turn. There was a long series of quiet preliminary inquiries that paved the way for the splendid demonstrations of spectrum analysis, but which were unappreciated and thrown into the shade after that brilliant discovery. A new epoch seemed to be suddenly created, and men cared little to know who had gone before and prepared for it. Unfortunately, this condition of things was favorable to the misappropriation of results gained by pioneer laborers. As the conductors of the "Philosophical Magazine" were of course aware of what had appeared in their pages, and were familiar with the early history of this train of researches, we had not much doubt that they would speak to the point when the time came. Our readers will observe that in the subjoined notice of Dr. Draper's work they have done so, thus decisively confirming the positions that we have formerly taken in regard to the priority of Dr. Draper in the investigations that led up to spectrum analysis.

Dr. Draper here brings together the scattered memoirs and essays that he has written during the past forty years on subjects connected with radiation and radiant energy. They are thirty in number, and, for the most part, are simply reprints; but in a few cases the original memoirs are condensed, and in one or two cases the article here given is the substance of a considerable number of detached articles. Most of them have already appeared in our pages; the earliest of them, on subjects relating to photography, appeared in 1840. "I have endeavored," the author tells us, "to reproduce these memoirs as they were originally published. When considerations of conciseness have obliged me to be contented with an abstract, it has always been so stated, and the place where the original may be found has been given. Sometimes, the circumstances seeming to call for it, additional matter has been introduced; but this has always been formally indicated under the title of 'Notes,' or included in parentheses" (p. x.).

It is probably known to our readers that Count Rumford made a donation to the American Academy of Arts and Science (similar to that which he made to the Royal Society) for rewarding discoveries and improvements relating to light and heat made in America. The Academy has been rather chary of bestowing its honors, and had only awarded its Rumford Medal four times before it made the award in 1875 to Dr. J. W. Draper "for his researches in radiant energy." This circumstance has determined the selection of articles in the present volume. It comprises the researches on which the award was founded.

The President's statement of the grounds of the award is given in the Appendix, and may be summarized as follows:

(*a.*) Independent discovery of Moser's images.

(*b.*) Measurement of the intensity of chemical action of light, by exposing to the source of light a mixture of equal volumes of chlorine and hydrogen.

(*c.*) Application of Daguerreotype process to taking portraits.

(*d.*) Application of ruled glasses and specula to produce spectra for the study of the chemical action of light.

(*e.*) Investigation of the nature of the rays absorbed by growing plants in sunlight.

(*f.*) Discussion of the chemical action of light, and proof that rays of all wavelengths are capable of producing chemical changes.

(*g.*) Researches on the distribution of heat in the spectrum.

And, finally, an elaborate investigation, published in 1847, by which he established the following facts, which we will give in the words of the award:

1. All solid substances, and probably liquids, become incandescent at the same temperature.

2. The thermometric point at which substances become red-hot is about 977° Fahr.

3. The spectrum of an incandescent solid is continuous; it contains neither bright nor dark fixed lines.

4. From common temperatures, nearly up to 977° Fahr., the rays emitted by a solid are invisible. At that temperature they are red; and the heat of the incandescing body being made continuously to increase, other rays are added, increasing in refrangibility as the temperature rises.

5. While the addition of rays, so much the more refrangible as the temperature is higher,

is taking place, there is an increase in the intensity of those already existing. The award then proceeds as follows: Thirteen years afterward Kirchhoff published his celebrated memoir on the relations between the coefficients of emission and absorption of bodies for light and heat, in which he established mathematically the same facts, and announced them as new.

We are, of course, aware that this is rather a burning question; but, whatever may be thought of the justice of these claims, there can be no doubt that the fact of their having been made on behalf of Dr. Draper by so distinguished a body as the American Academy of Arts and Science ought to be known, and that its judgment will receive at least respectful consideration whenever the early history of spectroscopic science comes to be written. And it is impossible not to draw attention to this fact in a notice, however brief, of Dr. Draper's volume; for, plainly, one of the motives of its publication is to assert his claims to priority of discovery in regard to the points above quoted. In fact, the four memoirs which bear directly on the subject of spectrum analysis are printed first in the volume, and are followed by a note in which Dr. Draper complains, though in very decorous language, that he has received considerably less than justice at the hands of M. Kirchhoff; and, by way of showing that he has tangible grounds for complaint, he makes the following quotations (p. 85) from M. Jamin's "Cours de Physique," in which results that he had previously established are formally attributed to M. Kirchhoff:

> M. Kirchhoff has deduced the following important consequences:
>
> Black bodies begin to emit at 977° Fahr. red radiations, to which are added successively and continuously other rays of increasing refrangibility as the temperature rises.
>
> All substances begin to be red-hot at the same temperature in the same inclosure.
>
> The spectrum of solids and liquids contains no fixed lines.*

Now, it may be said with very little qualification that what is here attributed to M. Kirchhoff is to be found distinctly stated in the first memoir in the volume before us, which was published by Dr. Draper in 1847. By experimenting with a strip of platinum heated by the transmission of a current whose force could be regulated, he ascertained that the temperature at which red rays are first radiated is 977° Fahr. He also ascertained that platinum, brass, antimony, gas-carbon, and lead became incandescent at the same time with the iron barrel in which they were gradually heated, and that the apparent exceptions presented by chalk, marble, and fluor-spar were due to phosphorescence. By raising the temperature of the platinum wire and analyzing with a prism the light emitted, he proved that the length of its spectrum gradually increased with the temperature until at 2130° Fahr. the full spectrum of daylight was attained; and it is clear that he regarded the result thus obtained as being generally true. That the spectrum of the incandescent platinum contained no dark lines had indeed come out only incidentally in the course of the investigation; still it was not by any means a point seen but not observed; for, in consequence of observing it, he resorted to a comparison of the spectra of incandescent platinum at different temperatures with the spectrum of daylight in order to determine their extent, instead of fixing their extent by the dark lines of the spectra themselves, which he had ascertained to be non-existent. On the whole, the above statement breaks down at nearly every point. What is therein referred to M. Kirchhoff was certainly ascertained before by Dr. Draper. Whether Dr. Draper was the first person to observe all these points is a very different question, and one we would by no means prejudge; indeed, without going beyond the limits of the first Memoir, it is pretty plain that the temperature of incandescence was known with considerable accuracy before Dr. Draper's experiment with the platinum wire; and it certainly was believed (if not proved) that the temperature was the same for all bodies.

* The above quotation is, we presume, to be found on pp. 463, 464, vol. iii., edition of 1866. If so, it is not exactly a quotation, but is made up of parts of a much larger statement. We may also observe that Memoir I. of the present volume is not in all respects an exact verbal reprint of this Memoir published in our "Journal" for May, 1847. This does not, however, affect the point at issue.

HABIT AND INTELLIGENCE. A Series of Essays on the Laws of Life and Mind. By JOSEPH JOHN MURPHY. New York: Macmillan & Co. Pp. 583. Price, $5.

THE first edition of this work appeared

nearly ten years ago. It was favorably received, and the author has been encouraged to pursue still further the line of thought there opened. This second edition is so nearly rewritten as to be practically a new work. Several chapters have been removed, and others condensed and modified, while much new matter has been added. It is obvious that there are two chief elements in this change: first, the progress of the subjects, or the increase of our actual knowledge concerning them; and, second, the author's own progress in mastering them. He is occupied by the most tangled and obscure of modern investigations, upon many of which the intellect of the world has but just fairly entered; these he discusses from an independent point of view, putting forth his own conclusions freely and fully. These are such as to merit attention; and the reader who desires to be thoroughly up in modern biological and psychological discussion will find much in Mr. Murphy's volume to repay attention.

THE NATIONAL DISPENSATORY: Containing the Natural History, Chemistry, Pharmacy, Actions, and Uses of Medicines, including those recognized in the Pharmacopœias of the United States and Great Britain. By ALFRED STILLÉ, M. D., LL. D., Professor of the Theory and Practice of Medicine and of Clinical Medicine in the University of Pennsylvania, etc., and JOHN M. MAISCH, Ph. D., Professor of Materia Medica and Botany in the Philadelphia College of Pharmacy, Secretary to the American Pharmaceutical Association. In one very handsome octavo volume of over sixteen hundred closely-printed pages, with over Two Hundred Illustrations. Extra cloth, $6.75; leather, raised bands, $7.50. Philadelphia: Henry C. Lea.

THE range of the sciences connected with materia medica and therapeutics is not only a very wide but also an ever-shifting one, growing by constant accessions of facts and material, condensing by sifting and discarding, and appropriating all that which has proved of real and more than ephemeral value. Pharmacopœias and compendiums of materia medica, in order to keep pace with both accessions and restrictions, and with general progress, have therefore to be revised or rewritten from time to time.

In the United States, where there as yet is no legally authorized Pharmacopœia, and the existing one is but the voluntary work of delegates from a number of medical and pharmaceutical societies and colleges, the "United States Dispensatory," of Professors Wood and Bache, for more than forty years has been the unrivaled standard in this special and important branch of the healing art, and as such has, to a very large extent, overshadowed the "Pharmacopœia." Since the appearance of the fifth decennial revision of the "United States Pharmacopœia" in 1873, and the failure of the "United States Dispensatory" to embrace in time its improvements, alterations, and additions in the way of a new commensurate edition, the want became more and more patent of a new critical digest, supplementing the Pharmacopœia, representing the advanced state of materia medica, and discarding the bulk of obsolete material. The announcement some years ago that Professors Stillé and Maisch, of Philadelphia, had engaged in the preparation of such a work was therefore received with the more satisfaction and confidence, as both authors are recognized authorities in their respective departments. The result of their joint labor has now made its appearance in the above-named volume, containing 1,540 pages, 88 pages of indexes, and 201 illustrations.

The practical importance of the objects of this work, the elaborate and comprehensive treatment of the immense material, embracing the natural history, chemistry, pharmacy, and the actions and uses, of the entire domain of the present materia medica, in a concise and lucid style, and commensurate with the advanced state of the kindred sciences, make the "National Dispensatory" at once a complete digest of its kind in the English language and a creditable publication of the American press.

Without entering in detail upon a critical survey of this voluminous work, of its many excellencies and comparatively slight and few shortcomings, it affords us special pleasure, in justice to its intrinsic value, its importance, and its prospective usefulness, to add our unqualified approval of the masterly way in which the authors have accomplished their task, and have succeeded in furnishing for general use, and to the professions of pharmacy and medicine in par-

ticular, a complete and trustworthy guide both for ready reference and for study. In this connection we hope that it may prove an effectual impetus to, and become largely instrumental in, the better, more correct, and more thorough study of pharmacology so much needed by pharmacists, druggists, and physicians, and at the pharmaceutical and medical schools of our country.

The publisher deserves due credit for the good style in which the book has been brought out. If shortcomings in this respect can be pointed out, they consist mainly in the comparative inferiority of quite a number of the woodcuts. While a few of them—as, for instance, on pages 314, 645, 866, and 1161—are equal to the excellent illustrations of the corresponding standard works of the French, and in particular of the German literature, others are less satisfactory, and in not a few cases inadequate to such an elaborate work and to the present state of xylography. Future editions can remedy this want, and in this respect enhance the value of the work by a liberal addition of pharmacognostical illustrations.

PUBLICATIONS RECEIVED.

Fasting Girls: Their Physiology and Pathology. By Wm. A. Hammond, M. D. New York: Putnams. 1879. Pp. 76. 75 cents.

Fashions of the Day in Medicine and Science. By H. S. Constable. Kingston-upon-Hull: Levy & Co. 1879. Pp. 300.

Sewer Gases. By A. de Varona. With Plates. Brooklyn: "Eagle" print. 1879. Pp. 157. 75 cents.

Mixed Essays. By Matthew Arnold. New York: Macmillan & Co. 1879. Pp. 347. $2.

Life and Letters of Frances Baroness Bunsen. By A. J. C. Hare. Two vols. in one. With Portraits. New York: Routledge & Sons. 1879. Pp. 516 and 486. $5.

The Teacher. Hints on School Management. By J. R. Blakiston. New York: Macmillan & Co. 1879. Pp. 106.

The Color-Sense. By G. Allen. Boston: Houghton, Osgood & Co. 1879. Pp. 294. $3.50.

Aids to Family Government. By B. Meyer. New York: Holbrook. 1879. Pp. 208. $1.

A Voyage with Death, and other Poems. By A. Welcker. Oakland, Cal.: Strickland & Co. Pp. 78.

Report of the New York City Board of Education. 1878. Pp. 419.

The Grocer's Manual. By P. H. Felker. Claremont, N. H.: Claremont Manufacturing Co. 1878. Pp. 312.

Chesapeake Zoölogical Laboratory. Session of 1878. With Plates. Baltimore: Murphy print. 1879. Pp. 170.

Native Flowers and Ferns of the United States. By Thomas Meehan. Parts 21, 22, 23, 24. Boston: Prang & Co. 50 cents each.

Report of the Ontario Institution for the Blind (1878). Toronto: Robinson print. Pp. 29.

American Chemical Journal. Edited by Ira Remsen. Vol. I., No. 1. Baltimore: Innes & Co. print. Pp. 76. $3 per volume, 50 cents per number.

Journal of Physiology. Supplement to Vol. I. London and New York: Macmillan. Pp. 62.

Nests and Eggs of American Birds. By E. Ingersoll. Part I. With Plates. Salem, Mass.: Cassino. Pp. 20. 50 cents.

Report of the Western Pennsylvania Institution for the Deaf and Dumb (1878). Pittsburg: Stevenson, Foster & Co. print. Pp. 55.

The Silkworm. Washington: Government Printing-Office. 1879. Pp. 31.

D'Unger's Cure for Dipsomania. Chicago: The Author. Pp. 16.

Organon of Science. By J. H. Stinson. Eureka, Cal.: Ayres print. Pp. 193.

Statistics of the Treasury Department (September, 1878). Washington: Government Printing-Office. Pp. 117.

Economic Monographs; International Copyright; Free Trade; Hindrances to Prosperity; Honest Money and Labor; National Banking. New York: Putnams. 1879. 25 cents each.

Report of the Eastern Penitentiary of Pennsylvania. Philadelphia: McLaughlin Brothers print. 1878. Pp. 130.

Journal of the Academy of Natural Sciences of Philadelphia. Vol. III., Part II. With Plate. Philadelphia: The Academy. 1876. Pp. 114.

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POPULAR MISCELLANY.

Famines in Ancient and Modern Times.—In a statistical paper recently published, Mr. Cornelius Walford gives a chronological table of the famines of which historic record exists, and then in twelve other tables notes the operation of the various causes, natural and artificial, which tend to produce famines, among the natural causes being floods and inundations, frost, drought, sundry other meteorological phenomena, insects, and vermin. The artificial causes are considered under the heads of war, defective agriculture, defective transport, legislative interference, currency restrictions, speculation, and, finally, misapplication of grain. What strikes the reader who glances at the first table is the great frequency of famines in earlier times, as compared with the present. Take, for instance, the record of two or three hundred years, beginning with the year 600, and compare it with that of the hundred years beginning with the year 1775. And, in making this comparison, it must be remembered that such events are sure to find permanent record to-day, while in earlier times the record was local, and has in many instances since been effaced. Mr. Walford's first table records, under the date 600 to 604, famine in France; 605, in England; 625, in Britain (*grievous*); 664, Ireland—great famine; 667, Scotland (grievous); 669, France—great famine; 669, Ireland—great scarcity, also in the following year; 680, Britain, from three years' drought; 695, England, and 700, Ireland—famine and pestilence for three years, "so that men ate each other"; 703, Italy—three years' famine; 712, Wales; 730, England, Wales, and Scotland—great famine; 748, Scotland; 759, Ireland—great famine; 768, same country—famine, and again 772; 774, Scotland—famine, "with plague"; 791, Wales—grievous famine; 793, England—famine; 803, Scotland—"terrible" famine; 822-'23, England—"thousands starve"; 824-'25, Ireland—great dearth; 836, Wales—"the ground covered with dead bodies of men and beasts"; 845, Bulgaria—great famine; 851, Italy and Germany—famine; 856, Scotland—a four years' famine began; 836, same country—famine, with plague; 872, England—famine "from ugly locust." In this century Paris was visited by famine three times. Now, turn to the record of the last hundred years. In 1775, at Cape de Verde—great famine—16,000 persons perish; 1789, France—grievous famine, province of Rouen; 1795, England—scarcity of food severely felt; 1801, United Kingdom—great scarcity; flour obtained from America; 1812, England and Ireland—great scarcity; 1813, Poland—famine consequent on an inundation; same year 5,000 souls perished in Sweden; 1822, Ireland—dreadful famine, produced by failure of potato crop; 1832, same country—famine—Parliament grants £40,000 for relief, and £74,410 subscribed in England; 1845, same country—Parliament advanced £10,000,000—275,000 persons supposed to have perished; famine lasted nearly six years; 1,029,552 persons died in this period from starvation and pestilence consequent on it; population reduced by these causes and emigration by about 2,500,000; 1847, France—scarcity; 1877, Brazil—upward of 200,000 of the population exposed to famine. We have purposely omitted notices of the famines in countries outside of Europe, or not settled mainly by Europeans. In such regions famine is at least as frequent and dread a visitant as ever it was. The contrast made by the foregoing figures is highly creditable to modern civilization.

The Age of the World.—The age of the world, as estimated by T. Mellard Reade, in a paper contributed to the London Royal Society, is enormously in excess of the limits assigned by certain physicists, and allows ample time for the production of all the changes of the organic and inorganic world postulated by the theory of evolution. Limestones, he remarks, have been in course of formation from the earliest known geological periods, but it would appear that the later-formed strata are more calcareous than the earlier, and that there has in fact been a gradually progressive increase of calcareous matter. The very extensive deposition of carbonate of lime over wide areas of the ocean-bottom at the present day is attested by the soundings of the Challenger. According to Mr. Reade, the sedimentary crust of the earth is at least one

mile in average actual thickness, of which probably one tenth consists of calcareous matter. In seeking the origin of this calcareous matter, it is assumed that the primitive rocks of the original crust were of the nature of granitic or basaltic rocks. By disintegration of such rocks, calcareous and other sedimentary deposits have been formed. The amount of lime-salts in waters which drain districts made up of granites and basalts is on an average about 3·75 parts in 100,000 parts of water. It is further assumed that the exposed areas of igneous rocks, taking an average throughout all geological time, will bear to the exposures of sedimentary rocks a ratio of about one to nine. From these and other data Mr. Reade concludes that the elimination of the sedimentary strata must have occupied at least six hundred million years. This would be the minimum age of the world. The author infers that the formation of the Laurentian, Cambrian, and Silurian strata must have occupied about two hundred million years; the Old Red Sandstone, the Carboniferous, and the Poikilitic systems another two hundred million; and all the other strata the remaining two hundred million.

Professor Clarke on Lockyer's Researches.—Professor F. W. Clarke, of Cincinnati, sends a letter to "Science News" in relation to the recent views of Mr. Lockyer on the compound nature of the chemical elements. Professor Clarke was himself early in that field, and published a very suggestive article in "The Popular Science Monthly" of January, 1873, on "Evolution and the Spectroscope," in which he announced on spectroscopic grounds the hypothesis that the evolution of planets from nebula had been accompanied by an evolution of complex from simple forms of matter. The idea was based upon the gradation in chemical complexity of the celestial spectra. About eight months later Mr. Lockyer put forth essentially the same views, resting them upon exactly the same evidence. Professor Clarke then goes over the ground recently taken by Lockyer, and recognizes that he has decidedly advanced the inquiry from a theoretical point of view. He traces the new lines of evidence, and considers that absolute demonstration may perhaps be attainable only by an actual decomposition of the elements in the laboratory; but a probability so strong as to command universal acceptance may be otherwise established. Mr. Lockyer has done much toward establishing this probability, and it is to be hoped that he will successfully continue his labors in the same direction. Meanwhile, chemists must seek new evidence from other sources, until, one way or another, the vexed question shall be laid definitely at rest.

The Distinctions between Man and Animals.—In a brief and sprightly, if not very profound article, a writer in the "Monthly Journal of Science" examines the validity of one of the principal distinctions which have been drawn between man and animals, namely, the supposed fact that while men progress as individuals, as communities, and as a species, animals stand stock-still, each succeeding generation attaining just the development of its predecessor and nothing more. The author, on the contrary, maintains that the individual man does not make progress from the cradle to the grave, but that, from the middle of life, and often indeed from an earlier date, he is a mere bundle of habits and prejudices: no further mental growth is possible, however long he may happen to survive. To a man, then, brutes exhibit no well-marked contrast, but a decided similarity: in the earlier part of life they are, like ourselves, capable of progress; but later their faculties are blunted, and, like man, they become stationary; as far, therefore, as individual progress is concerned, man and beast differ only in degree. There is also among mankind a national or tribal progress distinct from that of the individual and that of the species, but, like them, not unlimited in extent and duration. Nations decay, and the cause of this decay is to be sought in the decline of that which in a nation corresponds to vitality in the individual—the "tribal instinct." Among those animal species which live in organized communities or nations the very same phenomenon occurs, and every ant-hill might have its Gibbon. The author here cites the observations of Berthelot, already quoted in the "Monthly" (current volume, p. 248.) It remains to consider the real or fancied superiority of every generation of mankind

over the foregoing; this superiority the author calls in question. Even as regards knowledge and power, the advance which some claim as a characteristic of humanity is effected by exceptional individuals who arise in certain races under favorable circumstances only, and is quite compatible with long intervals of immobility and even of decline. Besides, it is not proved that the lower animals are literally incapable of progress. To enforce this point the author quotes certain interesting observations made by the writer of a work entitled "Flowers and their Unbidden Guests," who had for months been in the habit of sprinkling powdered sugar on the sill of his window, for a train of ants which passed in constant procession from the garden to the window. "One day he took it into his head to put the powdered sugar into a vessel, which he fastened with a string to the transom of the window, and, in order that his long-petted insects might have information of the supply suspended above, a number of the same set of ants were placed with the sugar in the vessel. These busy creatures forthwith seized on the particles of sugar, and, soon discovering the only way open to them, viz., up the string, over the transom, and down the window-frame, rejoined their fellows on the sill, whence they could resume the old route down the wall into the garden. Before long the route over the new track from the sill to the sugar by the window-frame, transom, and string, was completely established, and so passed a day or two without anything new. Then one morning it was noticed that the ants were stopping at their old place, the window-sill, and again getting sugar there. Not a single individual any longer traversed the path that led thence to the sugar above. This was not because the store above had been exhausted, but because some dozen little fellows were working away vigorously and incessantly up aloft in the vessel, dragging the sugar-crumbs to its edge, and throwing them down to their comrades on the sill."

The Earthquake of November 18, 1878.—Of the earthquake of November 18, 1878, Professor Nipher, of the University of St. Louis, says that it was felt over an area of fully 150,000 square miles, the region disturbed forming an ellipse, with its major axis reaching from Leavenworth to Tuscaloosa, a distance of over 600 miles. The minor axis extended from near Clarksville, Arkansas, to a point midway between Cairo and St. Louis, a distance of 300 miles. The region of greatest disturbance was along the Mississippi from Cairo to Memphis. Here the shocks were universally felt; the walls of buildings could be seen to move, and strong frame houses creaked as when every joint is strained by a strong wind. At Ironton, Missouri, the shock was so severe as to alarm some of the occupants of brick houses. Along the Missouri from Glasgow to Lexington the shock was also severe, awakening many families, who thought a heavy wind-storm was in progress. The shock appears to have been felt first at Glasgow at 11 h. 23 m. (St. Louis time). The shock traveled rapidly along the axis of the ellipse, reaching Cairo at 11 h. 48 m., and Memphis at 11 h. 50 m. At Little Rock it was distinctly felt, although not observed at Clarksville, which is thirty miles farther up the river.

Physiological Effects of Arsenic.—The physiological effects of arsenic have lately been studied anew by Gies, who administered minute doses of the poison daily for four months to pigs, rabbits, and fowls. The daily dose for a rabbit was 0·0005 to 0·0007 of a gramme, for a pig 0·005 to 0·05, and for a fowl 0·001 to 0·008. In all these animals the weight of the body increased, and the subcutaneous fat was augmented. In young growing animals the bones developed considerably, both in length and in girth, and they presented the peculiarity that, wherever in the normal state spongy tissue exists, it was superseded by compact bone. Moreover, just as Weigner found to be the case in animals supplied with small doses of phosphorus in their food, a compact layer of bone was found immediately beneath the epiphyseal cartilages of the long bones. This effect was apparent after the arsenic had been given for nineteen days, and where only 0·02 to 0·035 gramme had been taken. It was observed that animals fed in the same stable presented the same appearances in the bones, which Gies refers to the air being laden with the arsenic elimi-

nated by the lungs and skin of the animals under experiment, for he found that the same changes were observable in animals kept in a cage, the bottom of which was strewed with arsenic. Besides the changes in the bones, the heart, liver, kidneys, and even the spleen, underwent fatty degeneration. The young of animals fed with arsenic were invariably born dead, though they attained a large size, and presented remarkable hypertrophy of the spleen, and incipient changes in the bones.

What shall we eat?—Dr. E. C. Angell, author of a paper in "The Sanitarian" entitled "Alimentation in Health and Disease," would make wheaten food and not beef the basis of alimentation. In a natural and rational system of dietetics wheat and the allied seed-foods, including beans, lentils, peas, and rice, must, he holds, take the place now usurped by animal foods, including, besides flesh-meats, butter, cheese, eggs, and milk. Next should come the appetizing, juicy fruits, and then the plant-foods, which are neither seeds nor fruits, and which are generally styled vegetables. After these come the various animal foods, and last of all the stimulating spices, beverages, and other food adjuncts. According to Dr. Angell, "the true life-giving and mental, moral, and physical force-producing bread is neither more nor less than sound, ripe wheat when deprived of its thin outer silicious husk, coarsely ground and mixed with water, and subjected to just that degree of kneading and baking which will suffice to prepare it for mastication, insalivation, and the subsequent action of the gastric juice." The dough should be kneaded into rolls a little larger than the largest macaroni, and when baked the prpduct gets the name of "sticks." In these "sticks" we have every nutritious element of the grain, with no fermentation, no cryptogamic vegetation, no deleterious chemical or mineral ingredients. We have, furthermore, a substance that must be chewed, as it can not be swallowed without due mastication and insalivation, and consequently its digestion is insured. Attrition, or cold-blast wheat, coarsely ground and unbolted, contains all the natural nutritive elements of the wheat. Besides this, it possesses the mechanical properties which distend the intestines, promoting their peristaltic action; it is therefore antidotal to dyspepsia. For children it is specially valuable, and its substitution for common bread, and the use of fruits instead of flesh-food, until the deciduous teeth shall have given place to the permanent denture, would be of incalculable benefit and would contribute to the production of good teeth. "The early loss of these organs," says Dr. Angell, "is conclusive evidence that the prevailing system of dietetics is radically wrong."

Government Aid to Artisan Schools.—In England government aid is given toward the support of science schools for artisans and mechanics, a sum of money being granted to the teacher according to the number of students whom he succeeds in getting through the government examination. Furthermore, in order to encourage the students, valuable prizes are presented to those who obtain first-class certificates at the examinations, which, it may be added, are not *competitive*, that is to say, if every student succeeds in obtaining the requisite percentage of marks, all obtain what are termed Queen's prizes. If the class be one in which scientific apparatus is required, the Government pays half the cost of such apparatus. Already above 50,000 young men attain a respectable proficiency in one or more branches of practical science every year. In "Chambers's Journal," from which the foregoing particulars are taken, we find the following interesting account of the rise and progress of one of these science schools for young artisans: "In the town in which this school is situated, a few spirited young men determined to have a class during the winter. Their scheme at first met with some opposition, but the young men were bent on extending to their town the advantages which the Government of the country hold forth to the industrial classes to educate themselves; and, ere the first days of winter had gone, the class became an accomplished fact. The difficulty experienced in obtaining the requisite instruments for the class was got over partly by means of the aid from Government, and partly by the ingenuity of the young men

themselves, who constructed several of the more expensive pieces of apparatus. A great deal can be done in this way. At the very lowest computation, one half of the apparatus might be extemporized by the teacher, and, if (as was done in the town under consideration) the construction of every article were carefully explained to the students, it would give them a grasp and familiarity with the subject which they could not otherwise obtain. The subject being entirely new to every one of the students, their attention was kept up, and their interest in the work never allowed to flag, by an unsparing use of the apparatus in performing as many experiments as possible. It turned out, however, that those students who were likely to fail at the government examination would do so not because their information was defective, but because of their inability to put their thoughts into writing. From want of practice they experience so much difficulty in arranging their facts in intelligible sentences, that one half of their available time has passed before they have completed the answer to the first question on the examination paper. This difficulty was got over by giving the students questions to work at home, and having a written examination every month during the course of the session. The result proved the efficacy of this arrangement. Nearly sixty students have been examined in the first stage of the subject, and there has not been a single failure."

Japanese Archæology.—In a report of a lecture by Professor E. S. Morse, published in the "Tokio Times," we find the following list of human bones found in the kitchen-midden at Omori, their presence, together with other circumstances, indicating, in the opinion of the Professor, that the locality was once inhabited by cannibals (see "Popular Science Monthly," vol. xiv., p. 257): Right humerus; length of fragment, 195 millimetres; proximal end gone. Left humerus; length of fragment, 215 mm.; both ends gone. Left humerus; length of fragment, 160 mm.; both ends gone. Right ulna; length of fragment, 200 mm.; distal end gone. Right ulna; length of fragment, 180 mm.; both ends gone. Right radius; length of fragment, 80 mm.; upper portion only. Right femur; length of fragment, 150 mm.; proximal end and portion of shaft only. Right femur; length of fragment, 270 mm.; both ends gone. Right femur; length of fragment, 280 mm.; both ends gone. Right femur; length of fragment, 107 mm.; upper portion of shaft. Right femur; length of fragment, 304 mm.; articular surfaces broken; child. Left femur; length of fragment, 160 mm.; shaft only. Left femur; length of fragment, 270 mm.; great trochanter and head and distal end gone; child. Left femur; length of fragment, 85 mm.; lower portion only; articular surface gone; child. Right tibia; length of fragment, 135 mm.; upper portion of shaft. Right fibula; length of fragment, 205 mm.; both ends broken. Fifth right metatarsal; length, 65 mm.; distal articular surface partially gone. Left lower maxillary. Left parietal.

How the Humming-Bird feeds.—Mr. A. R. Wallace's account of the way in which the humming-bird takes its food, whether nectar or insects, would appear to be erroneous in the light of the observations made by W. H. Ballou, of Evanston, Illinois. According to Wallace, "the tubular and retractile tongue enables the bird to suck up honey from the nectaries of flowers, and also to capture small insects; but whether the latter pass down the tube, or are entangled in the fibrous tips and thus drawn back into the gullet, is not known." Mr. Ballou's observations are recorded in the "American Naturalist." He attracted to his house two humming-birds by a saucer of sirup placed on the window-sill, to which the birds would come every day to satisfy their hunger. They always alighted on the edge of the saucer, and *lapped the sirup* as a dog laps water. The question whether insects "pass down the tubes or are entangled in the fibrous tips and are thus drawn back into the gullet" was also solved by Mr. Ballou. Insects too large to pass through these tubes being placed in their way, the birds were observed to take them as readily as smaller ones. The insects were evidently secured by adhesion to the saliva of the tongue-tips, and thence drawn into the gullet. The author

thinks that the tubes of the tongue connect with the lungs rather than with the digestive passage. These interesting observations were abruptly terminated one day by the coming of a third "hummer"—a male—who drove the others from the window, and, in a fit of rage, darted at one of them, and thrust his bill well through its body; both then fell to the ground dead.

Wines as Intoxicants.—Supposing two wines, a white wine and a red, to contain the same proportion of alcohol, may the one be more intoxicating than the other? That such is the case appears from a communication to the London "Spectator" by Samuel James Capper, who declares it to be an incontestable fact that in all white-wine districts, and of course in all cider-producing countries, drunkenness is much more prevalent than where red wine is grown. Mr. Capper quotes the observations of a lady who was in the habit of spending six months of the year in a château on the Loire, while the other six months were spent on an estate near Dinan. "She assured me," writes Mr. Capper, "that the difference in the matter of sobriety was most marked between the peasants on the Loire, whose habitual beverage was red wine, and the Normans and Bretons, who drink cider, to the exclusion of everything else, even water." He adds that "in the Pays de Vaud the abundant supply of white wine is admitted by all thoughtful inhabitants to be a great curse. Very few laboring men attain old age, their nervous systems breaking down entirely, through their intemperate use of the product of the smiling vineyards that line the shores of Lake Leman. An hotel proprietor of great experience assured me that he found it better in every way to supply his servants and laborers with a cheap red wine from France than to let them drink the white wine of the country." Mr. Capper accounts for the difference in the effects of red and white wine by the fact that the former is very rich in tannin, which is absent in the latter. The tannin exercises an astringent influence, and closes the pores of the stomach, thus preventing the alcohol from going straight to the brain, as it does in the case of white wine.

Grief in a Chimpanzee.—That the chimpanzee is capable of feeling grief, regret for the death of a companion, Mr. A. E. Brown holds to be proved by the behavior of the surviving one of a pair of those animals kept for some time in the Zoölogical Garden of Philadelphia. The animals had been very much attached to each other; they never quarreled, and, if occasion required one to be handled with any degree of force, the other was always prepared to take its part. After the death of the female, her consort made many attempts to rouse her, and when this was found to be impossible his rage and grief were piteous. Tearing the hair, or rather snatching at the short hair on his head, had always been one of his common expressions of extreme anger, and he was now seen to do this frequently; but the ordinary yell of rage which he set up at first finally changed to a cry before unheard by the keeper, and which may be represented by *hah—ah—ah—ah—ah*, uttered somewhat under the breath, and with a plaintive sound like a moan. He made repeated efforts to awaken his dead companion, lifting up her head and hands, pushing her violently, and rolling her over. After the body had been removed from the cage he became more quiet, and remained so as long as his keeper was with him, but, catching sight of the body once when the door was opened, and again when it was carried past the front of the cage, he became violent, and cried for the rest of the day. The day following he sat still most of the time and moaned continually; but this gradually passed away, and from that time forward he has manifested a sense of a change in his surroundings only by a more devoted attachment to his keeper and a longer fit of anger when he leaves him.

Sensibility of the Eye to Light.—A highly interesting series of experiments on the sensibility of the eye to light is described by Charpentier, in a communication to the Paris Academy of Sciences. With the aid of a special apparatus for graduating at will the intensity of the incident rays, he finds that if the intensity be gradually increased from zero the sensation is developed after a certain minimum degree has

been reached. But, if the intensity of the stimulus be now as gradually diminished, the eye will continue to perceive it till it has fallen to one third or one fourth of the original minimum. In producing the initial sensation a certain amount of light has, so to speak, been wasted in putting the machinery in motion. Further, if the eye has been carefully shielded from the light for some minutes before performing the experiment, it will be capable of perceiving light which is fifty or even one hundred times less intense than that required to produce a luminous sensation. This enormous difference is equally manifested whether monochromatic or white light be employed. Now, if we apply a similar test to the sensation of color, we find that for the chromatic as for the luminous stimulus a certain minimum is needed to produce the sensation, which still continues to be excited when the intensity of the stimulus is progressively diminished. So far, the two sensations, of light and color, obey the same law. But if we proceed to compare the sensitiveness of the eye in full activity with that of the eye which has been allowed a period of absolute rest, we no longer find any such increase in its susceptibility to the chromatic stimulus as was observed in the case of light. This result is altogether opposed to the current opinion that the sensation excited by white light is really a resultant of the simultaneous development of several determinate color sensations; it shows, on the contrary, that the sensation of light is altogether independent of that of color, and really a simpler kind of reaction on the part of the visual apparatus.

"Oil on the Troubled Waters."—The fishermen of the Shetland Isles, as we learn from a writer in "Chambers's Journal," are wont, when in utmost peril during a storm, to throw oil on the waters to still them. They crush in their hands the livers of any ling or cod they may have caught, and keep throwing them astern and around them. "The effect," we are told, "is magical. The waves are not lessened in size; but they no longer *break*, and it is only from their breaking close to the boat and so being dashed in upon her and filling her that there is danger. The rapidity with which the oil spreads over a considerable space of sea around is marvelous, and scarcely to be credited except by one who has witnessed the phenomenon." An expedient so simple might often be of invaluable service in saving life and property. The difficulty and peril, for instance, of launching a boat from a sinking ship in a storm are mostly caused by the wind breaking the waves over the boat and filling her or dashing her against the vessel's side. "The danger of such a mishap would unquestionably be greatly lessened by throwing overboard some oil, which ought always to be kept handy. Boats also going from one ship to the assistance of another in distress, and life-boats on their way to a wreck, and boarding it, might often with very great advantage use a little oil, if its effects were only better known. Another case in which oil might be of the greatest service is when a man accidentally falls or is washed overboard. Life-buoys are thrown into the sea, the ship is brought to as quickly as possible, boats are lowered and a search made; but, before all this can be done, the vessel has run a considerable distance, and, although the poor struggler in the water may be a good swimmer and able to keep afloat for some time, the great difficulty is to find the exact spot where he is to be sought for. A life-buoy or a man's head is a small object to descry among heaving waves and white foam. If life-buoys were constructed so as to contain a small portion of oil in a little receptacle or India-rubber bag attached to them, to be punctured with a knife before being thrown overboard, the effect would be not only to prevent the sea from breaking over the castaway, so making it easier for him to keep afloat, but would indicate to the searchers almost the exact spot where to look for him."

NOTES.

THE commonly received theory of dew is that it results from the condensation of the moisture of the air by contact with surfaces of a lower temperature. This theory is rejected by Professor Stockbridge, of the Massachusetts Agricultural College. He holds dew to be the vapor from the soil condensed by the cooler air, and states as follows the results of his experiments: 1. The vapor of the soil is much warmer at night than the air, and would be condensed by it. 2. Va-

por from the soil is soon diffused and equalized in the whole atmosphere, but in the largest proportion when evaporation is taking place near the surface of the soil; and, other things being equal, plants nearest the earth have the most dew. 3. Dew under haycocks, boards, and like objects on the ground, could receive it from no other source.

PROFESSOR BAIRD has dissipated the cloud of mystery which from olden time has veiled the mode of propagation of the eel by his finding the ripe ovaries of the animal. It appears that what Professor Baird shows to be the ovary of the eel has been known under the name of "eel-fat." This "fat," under the microscope, is seen to consist of egg-cells, of which a single fish may contain as many as 9,000,000.

AT a meeting of the Baltimore Academy of Medicine, Dr. McSherry recounted the case of a lady who took cold two years ago, from sleeping in damp sheets, and has ever since been devoid of the sense of smell. Her sense of taste is also impaired to such a degree that she can not distinguish between different sorts of meats and vegetables. Pepper she recognizes by its pungency. The hearing is acute. Another physician present cited the case of a lady who lost the sense of smell several years ago, from catarrhal trouble. She is unable to distinguish the different kinds of food and drink. Her mother met with the same loss after typhoid fever, and never recovered from it. In another case the sense of smell was lost after illness, that of taste being retained.

AN examination of the blood of *Cephalopoda* by Frédéricq shows that in the oxidized state corresponding to that of our arterial blood, this liquid is of an intense blue color, and that as it loses its oxygen it grows pale. It contains a substance analogous to hemoglobine, in which a metal plays the same part as iron in the blood of superior animals, but in the cephalopod the metal is copper.

A SPANISH technical journal, the "Gaceta Industrial," pronounces American-made cartridges to be superior to all others, the superiority being due in part to the alloys used in the manufacture, in part to the machinery, and in part also to the skill of the workmen. Foreign governments have sent experts hither to study the methods in use in our factories, but the result has been unsatisfactory.

IN 1872 the population of the city of Tokio (formerly Yedo) was 595,905 souls. It has since nearly doubled, for the last census shows it to be now 1,036,771. The number of houses is 236,961, or one house per 4·37 of the inhabitants.

A WOMAN in England having received an injury on the leg which caused a profusely bleeding wound, applied a poultice of tobacco to the injured part. Soon the patient exhibited alarming symptoms, and a physician being called, found her extremely prostrated: there were dimness of sight, dizziness and confusion of thoughts, nausea, and vomiting. The poultice was removed, an antidote (strychnia) and stimulants administered, and the patient slowly improved.

THE yearly consumption of quinine in the United States is computed at 800,000 ounces; at an average price of $2.50 per ounce, this represents an annual outlay for this drug of $2,000,000. Of opium the annual consumption, whether as a medicinal agent or as an intoxicant, is 220,000 pounds, costing, at four dollars per pound, rather less than one million dollars.

THE cremation method of disposing of dead bodies is not making very rapid progress toward universal acceptance either in England or the United States. The medical press of the former country appears to be opposed to the practice. The celebrated crematory at Washington, Pennsylvania, the only one in the United States, has, we learn from the "Medical and Surgical Reporter," been converted into a factory for canning fruits!

IN the present year occurs the eighteenth centenary of the destruction of Pompeii and Herculaneum by an eruption of Mount Vesuvius. It is intended to commemorate this event in a becoming manner next November, and invitations have been issued to the most eminent Italian archæologists to be present on the occasion.

THE honey mesquite is one of the principal forest trees of Texas. It is a short, spreading tree, attaining an average trunk-diameter of eighteen inches. It belongs to the *Leguminosæ*, and bears pods nine to ten inches long, containing beans imbedded in a sweet pulp. Both the beans and the pulp are eaten by the Indians, and they form good fodder for horses. The wood is very hard and durable.

IN the summer of 1877 some remains of an old Roman bridge—viz., a number of oak piles and beams—were found in the bed of the Neckar, at Heidelberg. Some of the piles were drawn with the iron points or shoes which had been used to drive them into the ground, and these shoes were found to be of the same shape and strength as those used at the present day for like purposes. Of the seven piers which supported the roadway of the bridge, five were found *in situ* at equal distances (thirty-four and a half metres) from each other.

W. KINGDON CLIFFORD.